# HOW TO BECOME A COLLIERY MANAGER.

---

By HENRY DAVIES.

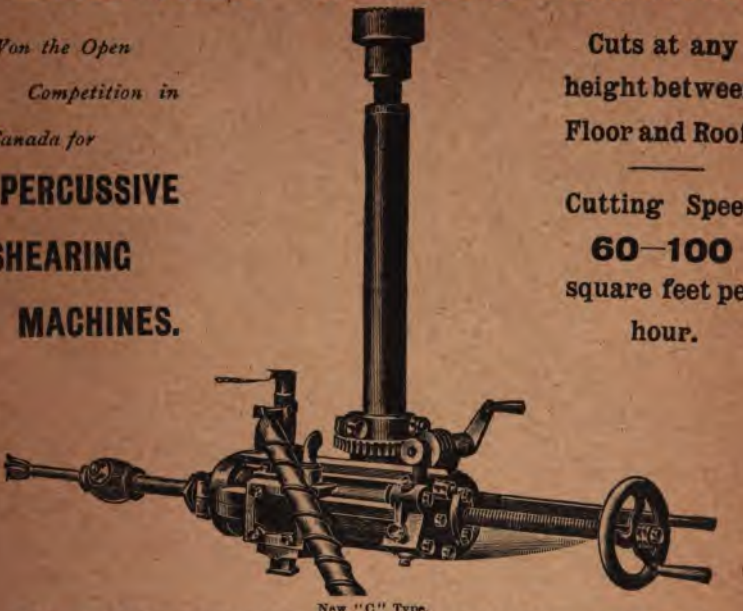
2/6

THE PATENT

# "LITTLE HARDY" PERCUSSIVE COAL-CUTTER

*Won the Open Competition in Canada for*

**PERCUSSIVE SHEARING MACHINES.**



New "C" Type.

Cuts at any height between Floor and Roof.

Cutting Speed **60—100** square feet per hour.

**Nearly 500 Machines at Work.**

---

High-class Tools for Miners and Contractors.

***Picks, Shovels, Spades, Forks, Axes, Hoes, Hammers, Wedges, Crowbars, &c.***


Hand and Power Boring Machines for Rock and Coal.

**'HARDY' DRILL STEEL.**

**HARDY PATENT PICK CO., LTD., SHEFFIELD, ENGLAND.**

# STEEL CASTINGS AND FORGINGS AND COLLIERY REQUISITES

Rollers and Frames, Pulleys and Frames, Pedestals, Rope Clips, Hammers, Picks, Shovels, Drill Steel, &c.

STEEL
TUB WHEELS and AXLES,
FITTED BY HADFIELD'S FAST METHOD.

ROWBOTHAM'S
Self-Oiling
WHEELS & AXLES.


COLLIERY TUBS fitted up complete in WOOD, IRON, OR STEEL.

PATENT
TUB CONTROLLERS,
TUB GREASERS,
PROP WITHDRAWERS

**Hadfield's Patent "Era" Manganese Steel**

Is the supreme material for Elevator and Conveyor Links, Grids for Coal Screens, and all Wearing Parts of Grinding and Crushing Machinery, &c.

# HADFIELD'S STEEL FOUNDRY CO., LIMITED, SHEFFIELD

Coal-mines and mining: Education

T. D.

# HOW TO BECOME A COLLIERY MANAGER,

***Together with an Appendix containing Twenty Years' Examination Questions in Mining.***

BY


## HENRY DAVIES,

***Director of Mining Instruction under the Glamorgan County Council.***



WIGAN:

THOS. WALL AND SONS LTD., PRINTERS AND PUBLISHERS,

*The Science and Art of Mining*, Rowbottom Square.

1906.

WIGAN:

THOS. WALL AND SONS LTD., PRINTERS, ROWBOTTOM SQUARE.

# CONTENTS.

# How to Become a Colliery Manager.

## INTRODUCTION.

### THE COLLIERY MANAGER.

The office of Colliery Manager to-day is not a sinecure; in fact, there are few positions where the duties are more onerous and responsible. To the youthful aspirant looking up from the bottom rungs of the mining ladder there is an attractive glamour surrounding the office, which engenders a healthy ambition in his breast. To the grey-headed worn-out veteran who becomes reminiscent, there is food for solemn reflection in the meditation on perils escaped and victories won. The strikes of labour, the disasters of the mine from inrushes of water and explosions of fire-damp, the legal proceedings against recalcitrant workmen who risked their own and fellow-workers' lives, enable him to realise to its fullest that "Uneasy lies the head that wears a crown."

Regular manual labour, accompanied by equally regular application to study in leisure moments, is the result of his vision of the ideal to the young man, and these are not only productive of a *mens sana in corpore sano*, but of a good workman, to be encouraged in his persistence, and self-reliance. These are not only the primary essentials in the evolution of a colliery manager, but their growth is a valuable addition to the sinews and assets of the nation.

Difficult examinations have to be prepared for and passed, practical experience has to be gained, and a position full of problems has to be secured by dint of application, tact, courtesy, and influence.

What does the position involve? A close practical acquaintance with all the sciences which may be applied to the service of man, an intimate knowledge of man himself with all his foibles and idiosyncracies, a constitution which will stand the wear and tear of the ceaseless worry and fatigues of colliery life, with its long days and many sleepless nights; a mind of an encyclopædic character, to grapple readily and apply skilfully all the interminable changes of the Truck Act, the Explosives, Compensation, Factory, and Education Acts, as well as the Coal Mines Act, with its many amendments; capacity to overcome the unavoidable troubles of the strata, and skill to steer clear of trivial causes productive of friction with the miners' unions.

And the reward! As far as emoluments count the manager may receive a salary varying from £150 to £1,000 per annum with sundry perquisites. Socially, he will be what he makes himself—the most abused man in the colliery village, reigning as a petty tyrant under the rule of his workmen, or one who by fair judgment, urbanity, and conscientious discharge of a difficult task wins the respect of his workmen and the confidence of his neighbours.

His power for good in moulding the character of the men in his charge is incalculable. By means of the music hall, concert room, institute, gymnasium, building society, or lecture hall, he has channels through which he may support all progressive movements calculated to benefit the workmen, and inculcate habits of thrift and temperance.

One of the busiest mining engineers in the South Wales coal-field takes the keenest interest even in the social well-being of his door-boys, and never misses an

opportunity of being present at their annual concerts, whilst his wife devotes her leisure to conducting evening sewing classes attended by the daughters of the miners.

The writer found during many years of pioneering work with the evening technical classes in South Wales, that the Colliery Manager of the intelligent type was invariably anxious and eager to promote the well-being of the workmen with whom he was associated, and by accepting office as chairman or secretary of the local education committee, or even by delivering occasional lectures on mining subjects, he rendered valuable service to the work of education. It is hoped that the reader who may be an aspirant for mining honours will realise that similar responsibilities will rest upon him. They are in no degree diminished by his refusal to accept them.

When colliery managers stimulate the workmen's ambitions for the provision of means for simple self-entertainment, a pleasant spirit of camaraderie is established, the happiest relations exist between capital and labour, and the work done is productive of the best returns.

## Chapter I.

## THE COAL MINES REGULATION ACT.

### Regulations Relating to Managers.

The Coal Mines Regulation Act (1887) states that:

Every mine must be under the control and direction of a "manager," and that his name and address must be sent to the inspector of the district.

The Manager must be the holder of a first-class certificate.

A mine must not be worked for more than fourteen days without a Manager.

Where a Manager is required by this Act he must exercise daily personal supervision, or nominate an Under-Manager, who must exercise daily personal supervision.

The Under-Manager must hold a certificate of the first-class or second-class, and will have the same responsibilities and liabilities as the Manager; but his nomination shall not affect the personal responsibility of the Manager.

A contractor for mineral, or person employed by such a contractor, is not eligible for the post of manager.

A mine in which not more than thirty persons are employed below ground shall be exempt from the provisions of this section, unless the inspector of the district, by notice in writing served on the owner or agent of the mine, requires that it be under the control of a Manager.

### Certificates.

There are two classes of certificates issued: (*a*) a first-class certificate of fitness to be a Manager; (*b*) a second-class certificate to be Under-Manager.

Only those who shall have had practical experience in a mine for at least five years are eligible.

Any Manager or Under-Manager, by reason of incompetence or gross negligence, found unfit to discharge his duties, or convicted of an offence against this Act, may have his certificate cancelled or suspended.

The examinations and qualifications of applicants for second-certificates shall be suitable for practical working

## BOARDS OF EXAMINATION.

For the purpose of granting certificates to Managers and Under-Managers, Boards for the purpose of electing Examiners are appointed by the Secretary of State. Boards are to consist of:

(*a*) Three persons, being owners of mines.

(*b*) Three persons who are, or have been, employed at a mine (not being Owners, Agents, or Managers).

(*c*) Three persons practising as Mining Engineers, Agents, or Managers.

(*d*) One Inspector.

The above Board may appoint examiners not being members of the said Board.

Before any Manager's or Under-Manager's certificate can be cancelled or suspended:—

(*a*) A public enquiry must be held.

(*b*) The official must be supplied by the Secretary of State with a statement of the case on which the enquiry is instituted.

(*c*) A person appointed by the Secretary of State shall undertake the management of the case.

(*d*) The official or his representative shall attend the enquiry and may be examined as a witness.

(*e*) Should the Court of Enquiry consider the manager or Under-Manager incompetent, grossly negligent, or guilty of unpardonable offences, against the Act, his certificate may be cancelled or suspended.

## THE COAL MINES (CERTIFICATE) ACT.

From and after the passing of this Act (1903), Section 23, Sub-section 1, of the Coal Mines Regulation Act, 1887, shall be read and construed as if the following were added thereto, viz.:—

"Or unless he has received a diploma in scientific and mining training after a course of at least two years at any University, University College, Mining School, or other educational institution to be approved of by a Secretary of State, or has taken a degree of any University to be so approved of, which includes scientific and mining subjects, and has also had practical experience in a mine for at least three years."

## Chapter II.

## DUTIES OF A COLLIERY MANAGER.

In addition to the Coal Mines Regulation Act, with its General Rules, which is applicable to all collieries, each coal-field has its own Special Rules, prepared to meet local conditions and requirements. The duties of the several officials of a mine are specified in these rules, and the following abstracts from the rules in force at South Wales collieries may be useful information to the aspirant for the Colliery Manager's certificate.

### Manager.

1.—The following rules are obligatory upon, and must be obeyed by, the Manager of the colliery.

2.—He must strictly observe and fulfil the provisions of the Act, and Special Rules, and must carry out and provide whatever is necessary for the safety of the Colliery and all its parts, and for rendering those provisions and rules effective; and he shall in person daily supervise the mine, or shall require the Under-Manager in person daily to supervise the same.

3.—He shall cause the Abstract of the Act and the Special Rules to be posted up, in legible characters, in some conspicuous place on the surface, at or near the mine, where they may be conveniently read by the persons employed thereat; and so often as the same become obliterated or destroyed, shall cause them to be renewed with all reasonable despatch.

4.—He has the responsible charge and direction of the colliery, and the control of all officers and other persons employed at the colliery.

5.—Where it is needful to divide the mine into parts or districts under the nineteenth section of the Act, he shall cause the quantity of air passing into each main intake, and in the respective splits or currents in the mine, to be measured and recorded in a book at least once in every month.

6.—He must provide fit and adequate machinery and structures for the purpose of the colliery, and take care the same are kept in repair, and he must provide upon the premises at the colliery a sufficient quantity of materials for the purpose of carrying on the colliery with safety.

7.—He shall direct the number of persons to descend or ascend at the same time in a shaft, and the number to descend or ascend in each compartment of a cage, and shall cause the directions specifying those numbers respectively to be legibly put up and maintained upon a notice board placed conspicuously near the shaft head, and at each stage or landing from which persons descend or ascend a shaft, and he shall cause the same direction and numbers to be recorded in a book at the colliery.

8.—He must design and properly lay out the ventilation of the mine, and must see that the same is adequately ventilated in compliance with the provisions of the first General Rule, and he must comply with the other provisions of that rule.

9.—He shall appoint all stations in compliance with the fourth General Rule, and shall cause the word "Station" to be legibly put up and maintained thereat. He shall direct the places where, and the manner in which, and the persons by whom naked lights may be used, and the places where only safety-lamps are to be used under General Rule 8, and shall, in conjunction with the workmen employed at the colliery, direct what safety-lamps are to be used in compliance with General Rule 9, and that they are examined in compliance with General Rule 10, and he shall appoint all lamp stations in compliance with General Rule 11, and shall cause the words "Lamp Station" to be legibly put up and maintained thereat.

10.—He is to direct the places in which blasting is to be permitted, and to make regulations under which gunpowder and other explosive substances may be taken into the mine and used, so as to comply with General Rule 12.

11.—He shall direct where borings shall be kept in advance in approaching old workings.

12.—He shall give the necessary directions for the construction of the man-holes and places of refuge required by the fourteenth and fifteenth General Rules, and shall cause all air-ways and travelling roads to be constructed of sufficient dimensions to comply with the Act.

13.—He shall cause the safety-valve of every boiler to be properly weighted, and shall give direction that the same may be frequently examined, to see whether there has been any interference with the weight to alter the pressure of the steam, and shall give direction that every steam-gauge and every water-gauge shall be frequently examined to secure its good order.

14.—He shall give directions that each boiler shall be cleaned as often as may be necessary.

15.—He shall provide, from time to time, a proper number of printed copies of the Abstract and Special Rules for use at the colliery.

16.—He shall appoint a proper person to do the duties of Book Clerk under the Special Rules.

17.—The wages payable to persons employed at the colliery shall be paid at the offices of the employer, over the door of which shall be the words "Pay Office." This rule shall include wages paid by contractors, sub-contractors, gangers, and masters of headings and stalls; but no information for a violation of this rule shall be laid unless it be proved as a fact that the wages were paid at a place forbidden by the eleventh section of the Act.

18.—He must from time to time appoint a sufficient number of competent officers to superintend the colliery, and all persons employed thereat.

19.—He shall cause all necessary plans of the mine, and all workings therein, and sections of the thickness of coal and of the strata sunk through, and showing the general direction and rate of dip of the strata, to be kept in compliance with the provisions of the Act.

20.—He shall accompany or appoint proper officers of the mine to accompany the inspectors under the thirty-eighth General Rule, when they make their inspection.

21.—The names of the Owner, Agent, Manager, and Under-Manager, and of all officers employed at the colliery, and of the office they respectively hold, shall be written in a book, with the dates of their first employment, and of their discharge, and each name shall be preceded by a number, and such officers shall be subordinate to the Agent or Manager, and to each other in the order of the numbers preceding their respective names.

22.—He shall give to the Inspector and Secretary of State all notices required by the Act to be given to either of them, and shall make all necessary returns to them.

23.—He shall direct the Pitman to examine and try over, at least once in every week, the sides of every shaft used for lowering persons into or lifting persons out of the mine; and he must require and see that all defects found therein are made good, and all weak places made safe.

24.—He shall take care that the provisions of the thirty-fourth General Rule are observed.

25.—He shall provide every checkweigher with proper facilities for the performance of his duty.

## UNDER-MANAGER.

26.—The following rules apply to the Under-Manager :—

27.—He shall in the absence of the Manager have the *daily personal supervision* of the colliery, and observe and fulfil the requirements of the Act and Special Rules. Where no overman is employed at a colliery, the duties of an overman under these rules shall apply to an Under-Manager.

28.—He shall be at the colliery in good time before each morning shift, to enable him to communicate with the officers under him.

29.—He shall, if any sudden danger, accident, or peril occur, immediately take measures to provide for the safety of all persons employed at the colliery, and report the circumstances to the Manager, and also do whatever may be needful to restore the colliery into good order.

30.—He shall from time to time examine all travelling roads, air-ways, working places, and wastes in the mine, and maintain a constant supervision over them and over the timbering, ventilation, and lighting of the mine, and all operations therein.

31.—He shall inspect the stables at proper intervals, and see that they are kept in order and properly ventilated.

32.—If at any time it is found that the mine or any part thereof is, by reason of noxious gas prevailing therein, or from any other cause whatever, dangerous or unsafe, he shall prevent any person entering the mine or that part thereof, unless to examine the mine or that part to explore such danger or the cause thereof ; and to remedy the same, or if any persons are already in the mine, he shall immediately cause every person to be withdrawn therefrom, or from such part thereof as is found dangerous ; and if the danger arises from inflammable gas, he shall inspect, or cause the same to be inspected, with a locked safety-lamp, and in every case he shall cause a true report of the condition of such mine or such part thereof to be made in a book, in accordance with the seventh General Rule. No person shall, except so far as is necessary for inquiring into the cause of danger, or for such removal or exploration, be re-admitted into the mine, or such part thereof as was so found dangerous, until the danger is removed and the mine or such part thereof is stated by such report to be safe.

33.—He may give any special directions without communicating with the Manager for the use of safety-lamps in any district or place in the mine, where he thinks they should be used by reason of any emergency.

34.—In approaching old workings and other reservoirs which may contain water or gas, he shall give directions to the persons employed, that the drift shall in no place exceed eight feet in width, and that the bore-holes required by the thirteenth General Rule are made and constantly kept at a sufficient distance in advance, and that the utmost caution is observed in tapping the water or gas, and he must see that those directions are obeyed. Neither water nor gas shall be intentionally tapped during working hours. Proper plugs shall be provided to stop the bore-holes if necessary.

35.—He shall stop the use of any shaft or plane, or machinery, or structure, which is out of repair, or out of order, or does not appear safe, and the working in any working place or travelling on any road which is unsafe, until the defect is made good, or the danger removed, and safety is restored, and directly that he knows of any such want of repair, want of order, insecurity, or danger, he shall cause the necessary means to be adopted for the correction of the defect, and to restore the mine to safety.

36.—He shall cause all entrances to any place not in actual use, or course of working and extension, to be properly fenced across the whole width of every such entrance, so as to prevent any person inadvertently entering the same.

37.—He shall give directions for the construction of all necessary air-ways and travelling roads, and shall see that they are made, and maintained of sufficient dimensions, and to comply with the seventeenth General Rule.

38.—He shall take care that the roadmen shall constantly keep clear every man-hole and place of refuge.

39.—He shall prevent and forbid any person being employed at the colliery until his name shall have first been entered in the register of persons employed thereat.

40.—He shall not permit the employment of any boy under the age of thirteen years or of any woman in the mine, and shall not permit the employment of any boy or woman under the age of twelve years on the surface.

41.—He shall take care that the provisions of the Act and of the Special Rules relating to the employment of boys, girls, and women are strictly observed by every person at the colliery.

42.—He must see that every officer under him, and every other person employed at the colliery, understands and fulfils his duty; and he must take care that every banksman and hitcher, and every other person in charge of the machinery at

a plane, understands the signals before he begins his duty, and shall examine each of them to satisfy himself that he knows his duty.

43.—He shall cause suitable timber to be provided for the colliers in the mine, in accordance with the twenty-second General Rule, and sprags and holing-props shall be set as by that rule is required.

44.—He shall observe the thirty-ninth General Rule, and shall not allow any person whom he knows to be unskilful, inexperienced, or careless, to work alone at any operation involving risk.

45.—He shall give immediate notice to the manager of any breach of the provisions of the Act or Special Rules by any person at the Colliery.

46.—He shall give immediate notice to the manager of any accident occasioning injury to any person in the colliery, and of any danger, defect, or want of repair in the colliery, or in any machinery or structure thereat.

47.—He shall enter, or cause to be entered, in a book, a report of every accident which occurs at the colliery, and which by the Act is required to be reported to the Inspector; and he shall also enter, or cause to be entered, therein every report made to him by any person of any breach of the provisions of the Act or Special Rules, and all reports required to be entered therein, under the first, fourth, fifth, seventh, and thirty-eighth General Rules.

## Chapter III.

## HOME OFFICE EXAMINATIONS.

For the granting of Colliery Managers' certificates twelve examination districts are arranged so as to meet the requirements of the Home Office. The areas of these districts are almost invariably co-terminous with those allotted to His Majesty's Inspectors under the Coal Mines Act.

There is no rule, however, to prevent candidates from one district attending the examination in another district, and this is extensively practised. Students who fail to pass the examination held at Cardiff for the South Wales coal-field proceed later in the year, if unsuccessful, to Bristol, Manchester, or elsewhere, and sit for the test under different regulations, and *vice versa*. If successful, their certificates entitle them according to the Coal Mines Act, to enter upon the responsibilities of a mine manager in South Wales or elsewhere. The relative value of the certificates from an educational standpoint is seldom considered.

All the first-class certificates are of equal value, according to the Government code of regulations, although it is a well acknowledged fact that, owing to the absence of any uniform standard of requirements by the examiners, there is a vast difference in the capabilities of the holders of certificates.

It appears almost incredible that it is possible, under any Government system of examinations for a post so onerous as that of a Colliery Manager, that a candidate having failed to pass the examination intended specially for the district in which he is trained, may proceed to another district, where the examiners have a lower standard and different syllabus of requirements, and if he succeeds in meeting these, may yet be recognised as being fully competent to manage a colliery in the first district.

The certificates officially establish a man as being competent under the present system to formulate the plans and regulations governing the conditions under which hundreds of men not only earn their livelihood, but risk their lives.

There is ample justification, therefore, for the movement initiated by the most progressive leaders of the mining pro-

fession for some change in the present anomalous state of affairs.

Mr. T. A. Southern, and other successful and experienced mining teachers emphasize the fact that there appears to be a complete lack of uniformity in the different coal-fields.

Although these examinations have been in operation for nearly 30 years, Mr. Southern says that there is not one single point in common between them except the one of age, and even in that simple matter a uniform standard was arrived at only in January, 1901. In no other question is there agreement. "Some centres publish the questions: some do not. Some publish the list of successful candidates without their having to apply for the information, what marks they have gained, or in what subject they have failed. Some give this information only if applied for, others refuse to give any such information whatever.

"Then again, some centres publish their system of marks; others do not. And in regard to the standard of questions set at the various examinations there is great diversity, so much so, that at some centres the second-class examination is much more difficult than the first-class examination at some other centres. In some cases the examinations are much more easy, and in other cases much more difficult than they ought to be. Questions are not uncommon which cannot, even by a great stretch of imagination, be said to have any bearing upon the competence of a person to manage a mine safely and efficiently, and in compliance with the Mines' Act; questions which, if published among mining men, would bring nothing but ridicule upon the examiner who set them.

"If, in connection with some big colliery explosions, which there is little or no doubt would not have occurred if the spirit and letter of the Mines Act had been strictly complied with (explosions which have undoubtedly resulted from what may have been charitably called an error of judgment, but which would be more accurately described as gross negligence, or even a flagrant breach of the Mines Act, or from sheer ignorance or foolhardiness), a careful enquiry was made, it would be found that even in many of those larger collieries with the exception of the Manager and Under-Manager, who are bound by law to have a certificate, many of the overmen, underground firemen, deputies, shot-firers, and other such officials are uncertificated men, and are not mining students, and would come very badly out of it if catechised even on some of the principal provisions of the Mines Act, or other matters of the greatest importance

in their own particular work and daily duties, and that at the same colliery, numbers of intelligent, experienced, and sensible men, holding certificates under the Mines Act, are working at the coal face as non-officials.

"As regards the examiners generally, however, they are governed by a desire to be strictly impartial; they are thoroughly fit for the position they hold, they spare no pains to perform their duties honestly, and they are thorough gentlemen in their dealings with candidates, but, unfortunately, there are some notable exceptions.

"Many Colliery Managers of to-day have had to fight against various obstacles and discouragements before they could get a certificate, and many most intelligent and most experienced miners have been unable to get a certificate, or have been deterred from trying for one by hearing of the experience of others who have tried."

There are certainly many good reasons for applying to the Home Secretary for a change in the methods adopted for testing a candidate's qualifications for the Mine Manager's certificate. Some change by which a more uniform system could be adopted would be acceptable to mining engineers, and gladly welcomed by mining students and teachers.

The mining community is ready for a scheme which would be productive of greater intelligence and efficiency, and of a necessity be a security against many accidents amongst our mine workers.

## CHAPTER IV.

## SCHEMES OF INSTRUCTION.

It is evident that the qualifications necessary in a Colliery Manager at the present day are vastly different from those of some thirty years ago, when the Coal Mines Regulation Act was passed, and it is certain that modern developments in coal mining demand an equipment of technical training which can only be obtained in a properly organised mining school. Of course, underground experience is as essential as ever it was.

The Manager to-day must not only be what is termed a good pitman, but also have no inconsiderable knowledge of mathematics, statics, hydrostatics, physics, chemistry, geology, general engineering, and a host of other sciences; he must also be a good business man and be able to deal discreetly with a very difficult class of labour.

Moreover, he is bounded by restrictions more numerous and severe than are imposed in any other industry.

The Coal Mines Regulation Act, 1887, stated that an applicant for a Colliery Manager's certificate shall have previously passed five years below ground, and until recently any period he may have passed in a college was not allowed to count. It was pointed out that in the large scholastic institutions of America and Germany (such as Columbia, and McGill, Clausthal, Frieberg, and Berlin) a mining student obtains a very much more complete scientific education than was possible under existing conditions in this country, and an amendment in the Act was brought about as described in a previous chapter.

Considerable difference of opinion still exists, however, as to the best course to adopt in the case of a lad intended for the mining profession. Should he specialise early in life, or should he have a broad general training until ready for a collegiate course? Should the time spent at the colliery precede or follow the college training?

A gentleman competent by experience to recommend, says:—

If we were asked to define generally the lines to be followed in preparing a lad to become a thoroughly competent Colliery Manager, we should advise that something like the following be the course adopted:—

He should be kept at a good public school until at least 16 years of age, and even longer if circumstances will permit. He shall have his attention and studies specially directed to mathematics, too much of which it is almost impossible to know; he should also be taught geology, mechanical and geometrical drawing, and mechanics. Let him, by all means, learn grammar, French, and German; they will do him no harm, but will expand his mind, and prepare him for travelling later in life to examine Continental mines, and examples of engineering skill in other countries. At the age of fourteen, before leaving the day school, he should be sent to a mining or technical school, and the subjects we would recommend that he should take are—mining, geology, steam, electricity, machine construction, and mechanics.

On leaving the day school, and commencing his term of apprenticeship at work in the mine, which should be for not less than three years, we would recommend that he should enter the surveying department for a part of the time. This will enable him to see something of everything that there is to be seen about a colliery. Some time should also be spent in the workshop, where he will obtain an experience and such information as will be invaluable to him as a manager. Of course, the greater part of the time should be spent underground gaining experience in the methods of working and ventilating a mine, of blasting and underground haulage, &c.

Now, if circumstances permit, two years at least should be spent at a Technical College where higher mathematics, practical geology, engineering, and chemistry may be studied and the Home Office certificate obtained.

In cases where from financial or other reasons this latter course cannot be adopted, the young mining student should avail himself of the many opportunities presented by the evening technical classes, for obtaining a training in scientific subjects which will enable him to pass the Government examinations with credit.

In many cases students after leaving the schools of preparatory training are articled to mining engineers for periods varying from three to five years. The premiums paid in such cases run from £50 to £500, according to the standing of the engineer. Excellent opportunities are afforded by this plan of becoming acquainted with office routine, and the actual work of the leading collieries.

Whichever course is adopted it is necessary to understand at the outset that men and things are more to be studied than

books. Many a Colliery Manager has been ruined owing to his lack of tact and discretion in dealing with the workmen entrusted to his charge.

Since our mines are now becoming deeper and more difficult to work, the introduction of elaborate machinery is necessary, and this involves a knowledge on the part of the manager of the principles of steam and mechanical engineering.

Foreign competition, too, by its keenness necessitates the introduction of labour-saving machinery to cheapen production.

Stringent State regulations are being annually introduced for the protection of the persons and the interests of miners, so that a higher educational status is essential on the part of the manager. (*Redmayne.*)

To try and meet these increased demands our Universities, Colleges, and Technical Schools are rapidly pushing forward well equipped laboratories and engineering departments.

At the Birmingham University College the complete course intended for those proceeding on a mining career is as follows :—

1.—Mathematics (including Algebra, Trigonometry, and Geometry).
2.—Inorganic chemistry, with laboratory practice.
3.—Geology and mineralogy.
4.—Physics and laboratory practice.
5.—Mechanical and electrical engineering.
6.—Coal and metal mining.
7.—Metallurgy and assaying in so far as applied to the treatment of ores only, and the analysis of fuel.

At the South Wales University College a special course has also been arranged :

Lord Kelvin, than whom there is no one more competent to express an opinion, said, when addressing the members of the South Wales Institute of Engineers, that he thought that engineers all over the world had a good deal to learn in respect of the value of University education. He did not think the South Wales engineers needed to learn that lesson. He believed they were well prepared to work harmoniously with the University, and he hoped they would consider practically what might be the best means of taking advantage of University training, and promote the good education of young engineers. He was afraid that he was apt to look back, but it was for the sake of looking forward and to apply the lessons learned from looking back. He remembered that when a boy just out of school, going to be an engineer in

Glasgow, he put on the fustian jacket and worked with the workmen. In those days workmen worked from six till six. He had in his mind one particular young man, and he was a type of the engineers in those days. He was up at five every morning, and went to work with his fustian jacket and with a neckerchief as the only distinctive part of his dress, and he went through five years' apprenticeship, and learnt a great deal of valuable matter in that time. He learnt the ways of the workmen, learnt to sympathise with them, and he also learnt how much was wanting of scientific knowledge to make the overseers and workmen able to do their duty effectually. It was in that respect he believed that Germany and France had shown such admirable results in practical engineering. He was not going to make comparisons, and say that they were better than British engineers, but he did say that the Germans particularly had learnt how to educate their foremen. It would be impracticable to think that the ordinary workmen in a great mechanical engineering establishment should go through the whole scientific course which an overseer of work ought to go through. A young man wishing to be an engineer, and not merely an ordinary workman, must learn the ways of workmen and also have a scientific knowledge. How was he to get it? Not by spending five years of his life on the good old hardy system from six in the morning till six at night in the workshop without any time to read up the scientific side of his subject. A plan that might well be carried out was that employers should make arrangements to take pupil apprentices on such conditions that they should be able to continue in the study of the scientific side of their work. The idea of the system of combining University training with workshop training was not sufficiently understood in any part of the country. Whether in Universities or Technical Colleges, there must be teaching and learning of science before a man could be a thorough engineer, whether as a civil engineer or mechanical engineer capable of guiding the world's work for the benefit of man. He would suggest that arrangements might be made whereby a young man could be allowed to attend two out of three terms in the University, giving himself wholly to University work. That would be nearly half a year. Let the other half of the year, less holidays, be devoted to practical work. He hoped employers in the engineering world, whether in mining engineering, engine-making, shipbuilding, or any other class of engineering, would be able to take in pupils on those

terms. It used to be that large fees were paid by apprentices, but the current was going in the direction of no fees at all. He did not think that any system of half a day in the University and half a day in the workshop could work out well.

## Chapter V.

## MINING INSTRUCTION IN GERMANY.

The following particulars relating to the courses in mining at various educational institutions in Germany are extracted from a "Report on Instruction in Mining and Metallurgy in Germany and the German Mining and Metallurgical Industries," by Dr. Frederick Rose, H.M. Consul at Stuttgart, received at the Foreign Office, September 18th, 1903.

Higher instruction in mining engineering, mine surveying, and metallurgy is provided for in Germany by the following institutes:—

| *Name.* | *Description.* | *Date of:* *Foundation.* | *Reorganisation.* |
|---|---|---|---|
| Berlin ..... | Mining High School ... | 1770 .. | 1860 and 1875 |
| Clausthal .. | Mining Academy ..... | 1775 .. | 1864 |
| Freiberg ... | Mining High School ... | 1765 .. | 1871 and 1901 |
| Aix ..... | Technical University ... | — .. | — |
| | Combined with the State Geological Institute. Department for mining and metallurgy. | | |

The general aim of these institutes is to provide thorough theoretical and practical instruction in mining, mine surveying, and metallurgy for future officials in the State mines, metallurgical and salt works, as well as for future owners, managers, and members of the scientific and working staffs of the mines and works; they are further intended for the prosecution of scientific research work for the furtherance of the above branches of technical instruction and industries. The conditions of admittance to the mining schools are as follows:—

*Berlin.*—(*a*) Leaving certificate of a gymnasium, real gymnasium or upper real school; (*b*) proof of one year's practical work. A lower degree of preliminary education entitles to admittance as extraordinary student, but the standard for the year of military service is the minimum accepted in these cases.

*Clausthal.*—(*a*) Certificate of at least six month's practical work; (*b*) certificate of good conduct; (*c*) leaving certificate of a gymnasium, real gymnasium, or upper real school. For

the present the following are also accepted:—(*a*) Leaving certificate of an upper real school with seven full annual classes; (*b*) leaving certificate of the highest class but one of the above-mentioned schools. Extraordinary students must possess at least the standard of the one year military service.

*Freiberg.*—(*a*) Leaving certificate of a gymnasium or real gymnasium; (*b*) age about 18. Extraordinary students must possess the qualification for the one year military service as minimum.

From the above it will be seen that the most important preliminary educational qualifications exacted from fully qualified students are the leaving certificates of a gymnasium, real gymnasium, or upper real school. The courses in these schools are arranged for a period of from nine to ten years, and must be preceded by a course in a preparatory school lasting from two to three years. Only those fully qualified students who possess the leaving certificate of one of the above schools are allowed to enter for the diploma examinations in mining and metallurgical engineering.

*Freiberg.*—The Freiberg Mining High School was founded in the year 1765 by Prince Xaver, in consequence of the representations made to him by the State mining authorities for more adequate facilities in mining and metallurgical instruction. In his proclamation on the subject upon the occasion of the foundation of the school, Prince Xaver mentions "that only a small part of mining science is taught at other high schools, and that the most important part can only be acquired in mining districts." He decreed, further, that natives of Saxony should be instructed free of cost. The first lectures were held in the following year at Easter. The school was supported by the State and by contributions from the silver mining industry, which has been carried on in Saxony for nearly 700 years. From the beginning it was largely attended by foreigners from all parts of Europe, and even from America, and it is still at the present day more frequented by foreigners and better known abroad than any other German high school. In the year 1871 the school was completely re-organised, and a director placed at the head, and in 1898 it was raised to a high school. According to the constitution of June 30, 1901, the school is under the direct supervision of the Minister of Finance, and is managed by a rector, who is appointed by the King of Saxony for the space of one year, after having been nominated for this office by the professorial council, which includes all the principal professors of the school. The professorial staff

comprises sixteen fully-qualified professors, ten extraordinary professors, two private lecturers, and three assistants. The following are plans of instruction for mining engineering, and mine surveying, with the number of hours devoted to lectures and practical work per week:—

### Lecture Plan.

### Mining Engineering.

| *Subjects.* | *No. of Hours per Week.* *Lectures.* | *Exercises and Practical Work.* |
|---|---|---|
| *First Year:* | | |
| Higher mathematics, Part I. | 6 | – |
| Descriptive geometry | 3 | 2 |
| Algebra | 2* | – |
| Spherical trigonometry | 2* | – |
| Physics | 6 | 1 |
| Inorganic chemistry | 4 | – |
| Mineralogy | 5 | – |
| Crystallography | – | 1* |
| Plan and section drawing | – | 2 |
| *Second Year:* | | |
| Higher mathematics, Part. II. | 2 | – |
| Mechanics | 6 | – |
| General mining engineering | 5 | – |
| Geology | 5 | – |
| Fossilology | 2 | – |
| Determination of rocks | – | 2* |
| Crystallography | – | 1† |
| Mineralogy | – | 2 |
| Physics | – | 2 |
| Blow-pipe testing | 2 | 2 |
| Machine drawing with designs, Part I. | – | 2 |
| *Third Year:* | | |
| Mine surveying and geodesy, Part I. | 3 | – |
| Geodesy | – | 2† 6* |
| Special mining engineering | 5† | – |
| Mining engineering | – | 2* |
| Ore-dressing | 5* | – |
| Briquette-making | 1* | – |

* Signifies Summer. † Signifies Winter.

| Subjects. | No. of Hours per Week, Lectures. | Exercises and Practical Work. |
|---|---|---|
| Machinery | 4 | – |
| Knowledge of mineral strata | 2 | – |
| Metallurgy | 4 | – |
| Building construction | 3 | – |
| Machine drawing with designs, Part II. | – | 4 |
| Political and State science (financial science) | 3† 2* | – |
| *Fourth Year :* | | |
| Mine surveying and geodesy, Part II. | 3 | – |
| Mine surveying | – | 6 |
| General law | 4† | – |
| Mining law | 4* | – |
| Designing of mining and metallurgical buildings | – | 4 |
| Ore-dressing | – | 2† |
| Mining and metallurgical calculations | 1† | – |
| Mining and metallurgical statistics | 1 | – |
| Electro-technics | 2 | 2 |
| Epitome of the metallurgy of iron | 1† | – |
| Saltworks | 1* | – |
| General mechanical metallurgical technology | 2 | – |
| Special mechanical metallurgical technology | 1* | – |
| Testing methods | 1 | – |
| Investigation of the gases forming in mines | – | – |
| **MINE SURVEYING.** | | |
| *First Year :* | | |
| Higher mathematics, Part I. | 6 | – |
| Descriptive geometry | 3 | 2 |
| Algebra | 2* | – |
| Spherical trigonometry | 2* | – |
| Physics | 6 | 1 |
| Mineralogy | 5 | – |
| General mining engineering | 5 | – |
| Plan and section drawing | – | 2 |

* Signifies Summer. † Signifies Winter.

| Subjects. | No. of Hours per Week. Lectures. | Exercises and Practical Work. |
|---|---|---|
| *Second Year :* | | |
| Mine surveying and geodesy, Part I. | 3 .. | – |
| Geodetic practical work .. .. | – .. | 2† 6* |
| Higher mathematics, Part II. .. | 2 .. | – |
| Special mining engineering .. .. | 5† .. | – |
| Geology .. .. .. .. | 5 .. | – |
| Mechanics .. .. .. .. | 6 .. | – |
| *Third Year :* | | |
| Mine surveying and geodesy, Part II. | 3 .. | – |
| Practical mine surveying work .. | – .. | 6 |
| Knowledge of the stratification of minerals and ores .. .. | 2 .. | – |
| General law .. .. .. .. | 4† .. | — |
| Mining law .. .. .. .. | 4* .. | – |
| National and State economy (financial science) .. .. .. | 3† 2* .. | – |

The students are not compelled to hear all the lectures given in the above plans of instruction, but can use their own discretion in choosing the necessary lectures ; those students, however, who wish to enter for the diploma (final) examination are recommended to attend all the lectures. The instruction given in the lectures is supplemented by repetitions and written exercises, practical work in the drawing-class rooms and in the mine-surveying department, in the laboratories and in the collections ; further, by practical work and instruction during excursions and mine surveying, by visits to mines and metallurgical work. A course of practical work is considered to be absolutely necessary before commencing to study at the school. For this reason a practical mining preparatory course is held every year from Easter to the end of July, in order to instruct the students, before commencing to study, in general mining and ore-dressing work. The Freiberg Mining High School is well equipped with institutes and collections of all descriptions, which materially assist the instruction given in the lectures.

*Berlin.*—The foundation of the Berlin Mining High School was due to the initiative of Frederick the Great, who wished

* Signifies Summer. † Signifies Winter.

to raise the prosperity of Prussia, which had suffered severely during the Seven Years' War, by fostering the development of the mining, metallurgical, and saltwork industries. To this end a course of lectures in mining and metallurgical subjects was instituted in 1770, and continued into the nineteenth century. In 1873 the Berlin Mining Academy was amalgamated with the State Geological Institute, and both were given a common constitution and management in 1875. The management of the Berlin Mining High School lies in the hands of two directors who are appointed by the King of Prussia. The educational staff of the Mining High School includes fourteen fully qualified professors, ten extraordinary professors, two private lecturers, and three assistants. The nature and duration of the scientific courses are as follows :—

| | | *Years.* |
|---|---|---|
| 1. | Students who wish to qualify for positions in the Prussian State Mines, metallurgical and saltworks .. | 3 |
| 2. | Mining engineering .. .. .. | 4 |
| 3. | Metallurgy (general) .. .. .. | 4 |
| 4. | Metallurgy of iron .. .. .. | 4 |
| 5. | Mine surveying .. .. .. | 2 |

The institutes, collections, and apparatus of the Berlin Mining High School are complete in almost every respect. A few special features may be mentioned. The library contains no less than 65,000 volumes and about 2,200 maps, drawings, and plans ; the annual increase amounts to about 800 volumes, and 150 to 180 maps, drawings and plans. The mineral collections are four-fold : The two principal collections, the collection for demonstration purposes and the collection for practical work. The collection for demonstration purposes contains about 7,000 minerals. The fourth mineral collection with crystals and crystal models is kept in a special room, to which the students have access at all times for purposes of study. The geological collections contain about fourteen divisions, and are most complete ; one of the divisions alone fills no less than twelve rooms in the first storey of the principal building. The collections for mining engineering, ore-dressing, and salt works contain more than 1,000 different objects, including models, instruments, tools, machines, appliances, materials, a number of mining antiquities and various local collections of raw and finished products. The chemical laboratory contains divisions for qualitative, quantitative, volumetric, gas, spectral and organic elementary analysis and for electro-

lysis; there exist also laboratories for general testing, iron testing, and the investigation of soils. The mechanical workshop manufactures models, tools, and small boring apparatus, and attends to general necessary repairs.

*Clausthal.*—The Clausthal Mining Academy has been developed out of a class for mining subjects which was attached to the "Lyceum Clausthaliense," a Latin school founded during the sixteenth century. In 1775 this class was separated from the Latin school, and in 1811 it was established in a separate building under the name of a mining school with about fifty pupils. From 1821 to 1844 it was combined with a forestry school, which was then removed to Minden, where it still exists as a forestry academy. In 1852 the duration of the courses of study was increased to three years, and since 1864 the school bears the name of the Clausthal Mining Academy. When reporting the academy was being re-built at a total cost of about £30,000; the chemical laboratory, which was erected in 1876, cost £5,600. The instruction is divided into a practical preparatory course, and the special mining and metallurgical courses. The practical preparatory course is intended for those who wish to commence the study of mining or metallurgy at the school, but have undergone no period of practical work; it consists of inspection and observation of the works, machinery, and methods of mining, metallurgy and ore-dressing, and of practical work as far as this is feasible. Students with this practical foundation are better enabled to comprehend the lectures which follow during the special mining and metallurgical courses, than those who come directly from the gymnasiums or "real schools" without any practical knowledge. The preparatory course begins every year in the first week after Easter and lasts six months, of which one month is devoted to ore-dressing, three to mining and water storage and supply, and two to metallurgy. The students work from six in the morning until twelve under the special supervision of overseers appointed for this purpose, and occupy the afternoons in drawing up a written description of what they have seen and done. The whole course is directed by a professor who lectures from time to time upon the work which has been, or is about to be, performed, and to whom the written descriptions of the students are submitted for correction. The special mining and metallurgical courses extend over a period of four years, and consist of lectures, repetitions, constructive and mathematical exercises, practical work in the laboratories, and excursions; the whole course of instruction

is assisted and supplemented by extensive collections of all descriptions, and by a well-stocked library of 30,000 volumes. The professorial staff consists of eight fully-qualified professors, five lecturers, and six assistants.

*Professorial Staffs and Proportion of the same to the Number of Students.*

| *Mining School.* | *Professorial Staff.* | *Number of:* *Staff.* | *Students.* | *Proportion of staff to Students.* |
|---|---|---|---|---|
| Freiberg ... | Fully qualified professors ..... | 12 | — | — |
| | Extraordinary ditto | 3 | — | — |
| | Lecturers ..... | 3 | — | — |
| | Assistants ..... | 3 | — | — |
| | Total ..... | 21 | 420 | 1 to 20 |
| Berlin ..... | Fully qualified professors ..... | 16 | — | — |
| | Extraordinary ditto | 10 | — | — |
| | Private lecturers .. | 2 | — | — |
| | Assistants ..... | 3 | — | — |
| | Total ..... | 31 | 269 | 1 to 9 |
| Clausthal .. | Fully qualified professors ..... | 8 | — | — |
| | Extraordinary ditto | 5 | — | — |
| | Assistants ..... | 6 | — | — |
| | Total ..... | 19 | 222 | 1 to 11 |

*Salaries.*—Berlin: Director, £500; substitute, £400; fully-qualified professors, £210 to £360, with a certain sum for house rent and one-fourth of the lecture fees. Clausthal: Fully-qualified professors, £190 to £330, and £24 for house rent. Freiberg: Fully-qualified professors, up to £270 and lecture fees; not fully-qualified professors, up to £180 and lecture fees. The remuneration of the assistants ranges from £60 to £90 or £100 per annum; the lecturers are remunerated from the proceeds of the fees for lectures. In considering the above salaries, it must be remembered that all professors and lecturers who are definitely engaged by the State are entitled to pensions upon retirement. It may also be mentioned that professors and lecturers may add to their incomes by private work.

*Fees.*—Clausthal: Lectures, 3s. per term for every lecture of one hour per week. Instruction in testing, blow-pipe analysis and volumetric analysis, 4s. 6d. per term for every hour per week. Chemical laboratory, winter £3; summer, £2 5s.; per month, 18s. Examinations, £6 5s. for Germans and £12 10s. for foreigners, for the preliminary and final examinations for the diploma of mining engineering and metallurgical engineering. Freiberg: Entrance fee, 10s.; diploma examination, £2 10s. for Germans and £5 for foreigners. Lectures 6s. per year for every lecture of one hour per week. Not fully-qualified students pay up to 10s., and foreigners are required to contribute £10 to the academy treasury. Further fees for practical work and for the necessary drawings for certain lectures are as follows:—

| | *Fee per year.* £ s. d. |
|---|---|
| Practical work in: | |
| Mining preparatory course .. .. | 1 10 0 |
| Metallurgical preparatory course .. | 0 10 0 |
| Physical laboratory .. .. .. | 0 6 0 |
| Qualitative chemical analysis .. .. | 1 10 0 |
| Quantitative chemical analysis .. .. | 1 10 0 |
| Volumetric analysis .. .. .. | 0 6 0 |
| Technical gas analysis .. .. .. | 0 6 0 |
| Geodesy .. .. .. .. .. | 0 15 0 |
| Mine surveying .. .. .. .. | 1 0 0 |
| Testing .. .. .. .. .. | 1 0 0 |
| Iron testing .. .. .. .. | 0 15 0 |
| Blow-pipe testing .. .. .. | 0 6 0 |
| Drawings for lectures in: | |
| General mining engineering .. .. | 0 3 0 |
| Special .. .. .. .. .. | 0 3 0 |
| Ore-dressing .. .. .. .. | 0 3 0 |

In 1901, there were at Berlin 245 Germans and 24 foreigners; at Clausthal 185 Germans and 37 foreigners; whilst at Freiberg there were 280 foreigners compared with 186 Germans.

## CHAPTER VI.

## GLAMORGAN COUNTY COUNCIL.

### SCHEME FOR INSTRUCTION IN MINING FOR EVENING SCHOOLS.

The scheme adopted by the Glamorgan Education Committee for instruction in mining is arranged in three stages, as follows :—

I.—Introductory Course.—For lads in the upper standards of primary schools.

II.—Preparatory Course.—For students attending evening continuation schools.

III.—Organised Course.—For students attending technical classes.

I.—The course for the instruction of lads in the upper standards of primary schools in mining districts consists of six lessons, which should be given during the last year of a boy's attendance at school. The intention of the Council is—(*a*) to make the boys acquainted with the Government rules framed for the miner's safety ; (*b*) to teach them how to avoid the commonest causes of accidents ; (*c*) to create a desire for further information bearing upon the principles underlying operations in the mine. Where no member of the school staff is competent to give the necessary instruction, the services of the committee's travelling teachers may be requisitioned.

Lessons on the following subjects should be given :—

(*a*) Coal, and how it was formed.
(*b*) Coal mine gases, and how they become dangerous.
(*c*) The safety-lamp, and how to use it.
(*d*) How a colliery is ventilated.
(*e*) How the coal is worked in the mine.
(*f*) Rules framed for the miner's safety.

In order to induce teachers to qualify themselves for imparting instruction in these and similar subjects, it was decided by the committee that some advantage in the scale of salaries should be adopted, and in selection for promotion preference should be given those who make themselves efficient in this subject.

It was also decided that the Inspectors of Primary Schools should award certificates to those pupils who attended a full course of lessons in the above subjects, and gave evidence to the Inspector that they had profited thereby.

### II. Preparatory Course for Evening Continuation Classes.

As there are many young miners anxious to continue their education from the point they reached in the Primary Schools, who are insufficiently prepared in the rudimentary work for admission to the technical classes, a special preparatory course in mining has been arranged for Evening Continuation Schools. The syllabus for this stage includes instruction in the following subjects:—

(*a*) English grammar and composition.
(*b*) Mathematics—arithmetic, mensuration, and algebra.
(*c*) Elementary drawing—freehand, model, and geometrical.
(*d*) Elementary science of mining.

While, in order to arouse the interest of the student, it may often be necessary to approach a subject from the standpoint of the miner, yet there must not be any slavish narrowness of treatment in this respect; generally, the instruction in the preparatory subjects should be such as would be useful to any industrial student, and, in fact, in many cases, the classes will be attended not only by those engaged in mining, but by others also engaged in such occupations as building, engineering, &c.

### III.—Organised Course for Students attending Evening Technical Classes.

This is a complete course specially arranged to meet the requirements of those—(*a*) who are desirous of securing certificates of competency of the first or second class under the Home Office; (*b*) who are candidates for the mining or engineering scholarships offered by the committee; or, (*c*) those who are anxious to become really efficient in the science of mining. The course is divided into four stages as follows:—

*First Stage* (First Year):
(*a*) Practical Mathematics.
(*b*) Mining.
(*c*) Mechanics and Heat.
(*d*) Geology.

*Second Stage* (Second Year):
(*a*) Practical Mathematics.
(*b*) Mining.
(*c*) Mechanical Drawing.
(*d*) Heat and Chemistry.

*Third Stage* (Third Year):
(*a*) Practical Mathematics.
(*b*) Mining.
(*c*) Applied Mechanics.
(*d*) Electricity and Magnetism.

*Fourth Stage* (Fourth Year):
(*a*) Mining.
(*b*) Mine surveying.
(*c*) Heat and the steam engine.
(*d*) Electric lighting and the transmission of power.

Efforts are made to establish preparatory, or first stage classes wherever there is a populous mining village. Second stage or advanced classes are fewer in number, and opened only at suitably equipped centres. The former classes are generally conducted by resident teachers, who may be engaged at the collieries or primary schools during the day, and the latter by members of the committee's travelling staff of teachers.

### SCHOLARSHIPS TENABLE AT THE UNIVERSITY COLLEGE, CARDIFF.

Several scholarships of the value of £30 per year, each with free tuition, tenable at the University College of South Wales and Monmouthshire, are annually offered for competition to students who intend pursuing a course of studies in mining or engineering.

The syllabus of subjects for examination, and conditions relating to these scholarships, may be obtained on application to the Chief Education Official.

### TRAVELLING SCHOLARSHIPS.

A limited number of scholarships will be awarded annually to enable mining students in Stages II. and upwards to visit the best equipped collieries in the South Wales and other coal-fields.

### SUMMER COURSE FOR TEACHERS AND ADVANCED STUDENTS.

A short summer course in mining and correlated subjects will be held each year. It is intended for teachers engaged in evening class work, and advanced students. Scholarships will be awarded selected students, to cover the cost of tuition and a part of the expenses connected with attendance at the course.

### TRAVELLING EXPENSES OF ADVANCED STUDENTS.

The travelling expenses of advanced students attending special centres will be paid by the County Education Committee,

provided that 80 per cent. of the possible attendances are made in each subject. The train fare to the nearest available centre only will be allowed.

### Special Lectures.

A short course of special lectures has been arranged for officials and miners, who, for various reasons, are not members of the committee's evening classes. This course bears directly upon the cause and prevention of colliery accidents.

### Tours of Mining Students.

(1) The privileges of the committee's travelling scholarships may be enjoyed only by students in Stages 2, 3, and 4 of the County Syllabus, and only once in each stage.

(2) The tours in 1906 and future years will be as follows :—

For students in Stage 2 : The South Wales coal-field.

For those in Stage 3 : A coal-field in Mid or North of England or Scotland.

For those in Stage 4 : A Continental coal-field.

(3) Twenty-five scholarships will be awarded in each stage, subject to a detailed programme in each case being submitted to and approved by the committee.

(4) The scholarships for the tours will be awarded on the results of examinations in mining and geology, which will be held by the committee on April 23rd and April 27th respectively. Candidates will be arranged in order of merit, according to marks received.

(5) Only students who present themselves for the Board of Education Examination in the second or higher stages of mining, and who have made 20 attendances (with the manager's certificate proving the student to have been engaged on night shift 15 attendances), will be eligible for the committees' travelling scholarships.

(6) The value of the above scholarships is as follows :—For Continental Tours, £8 ; for North Country, £4 ; and for South Wales, £3.

(7) A limited number of these scholarships will be awarded to teachers of evening technical classes taking at least two of the subjects of the mining course, and teachers of evening continuation schools who have taught the preparatory course in mining in their schools.

(8) One half the amount of the scholarships awarded will be paid the student when he enters upon the tour, and the remainder on receipt of a satisfactory report on the collieries, &c., visited, provided that the report be received within one

month of the return of the party. If the report be not received within one month, one half of the scholarship will be forfeited.

(9) The Continental tour will occupy at least eight days; North Country tour about six days; South Wales tour, six days.

(10) Time of Tours: end of June or beginning of July.

### SUMMER COURSE IN MINING.

This course will continue for three weeks, and scholarships, to cover the cost of attendance, &c., of the value of 3 guineas each (except to teachers continuing to receive salary from their Local Education Authority), one half of which shall be paid at the end of ten days from the commencement of the course, and the remainder on the twentieth day, provided a satisfactory report has been made as to diligence, &c.

The number of scholarships for the county is fixed at 36, and, in accordance with the recommendations of the Board of Education, at least one quarter the places allotted will be reserved for teachers.

Applicants from the Associated Counties, outside scholarship holders, will be admitted to the benefits of the course on the payment of a fee of £1 10s. Students from counties outside those represented by the Mining Education Board will be charged £2 10s.

The course may be divided into three parts, as follows, to meet the requirements of students pursuing studies in mining engineering.

Course A—Mining, chemistry and physics of mining, practical mathematics.

Course B—Mining, practical mechanics, geology.

Course C—Mining, surveying, electric lighting and transmission of power.

It will commence in August.

## Chapter VII.

## TECHNICAL EDUCATION IN MINING.

By Professor Henry Louis, M.A., A.R.S.M.

Taking first the working miner, he should leave school with the rudiments of a sound education, a knowledge of English grammar, history, &c., a decent (and often a good) handwriting, and a knowledge of arithmetic, going, say, but little beyond decimals. He will then commence his mining career either on the surface, or else as a trammer, driver, trapper, &c., underground, and thus begins his technical instruction—a very different thing from technical education—in the art of mining. He ought to acquire facility in composition, to advance his knowledge of arithmetic, learn the rudiments of mensuration and geometry, and, if possible, also of mechanics or physical science. At the age of 15 or 16 he ought to be beginning elementary science, more especially chemistry, physics, and geology, learn as much of the elements of algebra as will enable him to understand and use a formula, and as much Euclid and geometry as will enable him to grasp the elements of surveying. After two or three years more he should take up the subjects of mineralogy, mechanics, steam, hydraulics, applied electricity, and similar applied science subjects, and finally devote a considerable portion of two or three years to the theory of mining. A course of ambulance lectures and a little elementary physiology might well be introduced during the same period. Meanwhile his practical training underground will have been progressing steadily, and, if fairly intelligent, active, and strong, he ought also to have acquired a sufficient amount of manual skill in his work. By this time the miner, whose educational programme we have been sketching, should be about 22 years of age, and, if a coal miner, he should now have no difficulty in getting his second-class certificate. At the same time, few men are fit to be placed in a position of authority underground till they are 25 at least; this is perhaps the lowest age at which a young coal miner ought to attempt to sit for his first-class manager's certificate. His scientific work in these last three years would consist of much the same subjects as in the previous few years, only it must be of a more advanced character.

Throughout the mining districts of the country a fair and steadily increasing number of young men is to be found anxious to take advantage of the educational facilities offered to them. The point which the writer has more than once had occasion to urge, must once again be repeated and emphasised, that the better education of the working miner is the best possible safeguard against accidents. There is no need to accumulate proofs of this statement, since any table of statistics of mining accidents will give ample evidence that the vast majority of them are due to ignorance or gross thoughtlessness. Fully two-thirds of the annual roll of accidents are preventable, and preventable by the training of the miner in thinking power, and in the elementary principles of science. The apathy of the miners' unions of this country towards the teaching of the sciences underlying their daily work is a standing disgrace to them and to their leaders.

Taking next the question of the training of mining engineers, we are confronted by a series of rather more complex problems. The aspect of mining engineering is changing rather rapidly; the days of small concerns, living from hand to mouth, and trusting to luck, are clearly numbered, and the mining engineer of the immediate future will be called upon to control vast undertakings depending for their profits upon a large tonnage of production, accurately calculated, and worked with the narrowest possible margin. Under these conditions it will only be thoroughly scientific administration that will be able to keep expenses below income, and all the resources of modern physical science will have to be pressed into service. The first condition needed for the higher scientific training of mining engineers is such an alteration of the law as shall bring coal and metal mining under the same conditions, as shall insist on a minimum of scientific training, as shall allow three years spent at a recognised Mining College, together with the passing of examinations in science of a specified standard to rank as part of the five years' apprenticeship required, and as shall allow time spent underground in a recognised foreign or Colonial mine to also count (possibly under certain restrictions) towards the period of apprenticeship. At the same time the examinations and the conditions of admission to examinations, ought to be made uniform throughout Great Britain. With a law thus amended, the writer would be far more hopeful of sound progress in scientific mining than he is at present.

A lad prepared to enter any Mining College should have received an education such as is provided on the modern side of any good school. There will, no doubt, be fairly universal agreement as to what science subjects should be studied at the college, the only difference of opinion will be as to the amount of each required, that is to say, the minimum amount. The writer personally holds that the mine manager does not need to read mathematics very deeply; it is essential that he should know the lower branches most thoroughly, but he can well limit his work to the elements of the calculus and of analytical geometry. A considerable knowledge of chemistry is required, not only because a mining engineer ought to be able to analyse and assay for himself any unknown substance that he may come across in his workings, but to enable him to understand the sometimes complex reactions that are continually taking place in the mine as fresh portions of minerals are exposed to the action of air and water. In physics, the rudiments of heat and optics alone are required, whilst electricity should be thoroughly studied, especially as regards its technical applications, and the student should make himself thoroughly familiar with electrical measurements. Geology is, of course, a most important subject, stratigraphical and physical geology being the branches that need most attention; the rudiments of lithology and palæontology are quite sufficient, the more advanced portions of these subjects being best left to specialists. On the other hand, economic and determinative mineralogy require thorough study. The mode of occurrence and distribution of useful minerals is a special subject that must also be known thoroughly. These are all the pure sciences that are absolutely needed; their application embraces a large number of subjects, such as engineering (including mechanics and steam), metallurgy, and the art of mining with its various sub-divisions, including the dressing and washing of minerals, and mine surveying. The latter subjects are, of course, the chief subjects that the student has to learn. Mine surveying must undoubtedly be taught practically as well as theoretically, and a properly trained mining student ought, when he leaves the Mining College, to be quite familiar with the use of all surveying instruments and the method of executing surveys, and to need nothing except practice to make him a competent surveyor. In this connection it may be as well to point out the great want there is in this country of any recognised examination for mine surveyors which should set a standard of proficiency. The subject of dressing of minerals requires

to be treated practically, best perhaps in a small laboratory, fitted with light breaking machinery, and dressing machinery such as sieves, handjigs, spitzkasten, shaking tables, &c. These should all be on quite a small scale, and constructed whenever possible of glass ; they should be capable of treating small quantities of mineral, say some 10 lb. or so at a time, so as to allow the student to control a machine thoroughly, and vary all its conditions of work easily and rapidly, and yet obtain a sufficient quantity of material to enable him to test thoroughly the products obtained. Concentrating laboratories have been brought to a high pitch of perfection in the United States, that at the Massachusetts Institute of Technology being a model of what such laboratories should be. The writer holds that the establishment of such a laboratory in the United Kingdom is one of the needs of the day. The most difficult question to settle, and perhaps the one in which there is room for the widest divergence of opinion, is as to what extent students should themselves actually work in mines. The writer is rather inclined to think that we have never, in this country, given the American system of "Summer Mining Schools" a fair trial. In this system the student spends his long vacation each year in a different mining district. He goes underground every day, and after a few days spent in familiarising himself with the general character of the mine, he is assigned to each particular portion of it in rotation, and is made to study this exhaustively, care being taken to so parcel out his work that he gets to see every different mining operation that is going on in the mine in question. He has to keep a journal, and make full notes of each day's work, an outline scheme being given him that shows him exactly to which points he should direct his attention. One of the most experienced professors in mining in the United States writes to the author on this subject, that the essential conditions of success are :—"Maintaining strict discipline in the class," "dividing the class into squads," and "requiring a definite amount of work each day," and on the important question of safety he says that : "There has been but one accident, a broken arm, in 20 years." Another very open question, which, however, most often crops up in the case of coal-mining students, is whether or not they should serve a portion of their time underground before entering the Mine College. On the one hand, it is argued that it is better for them to get some idea of what the actual work will be like before definitely commencing their college career, and that they will understand the value of their

theoretical work better if they first have some conception of its practical application. On this question the writer holds that the student should get his college work done before he commences to do his regular work in the pit. His practical work will do him more good, he will learn it more thoroughly and appreciate it more critically if he understands the scientific basis that underlies it. It seems more logical to commence with the theory and to learn its applications afterwards, than to reverse this process. It will appear that the writer considers our present system of mining education to be a faulty one, though materials for its improvement are readily available. An effectual improvement can, in his opinion, be effected only by an alteration in the law, and the chief reforms the writer would advocate are the following:—

1.—Every manager of a mine, whether coal or metalliferous, to hold a certificate.

2.—Certificates to be granted upon examination to be controlled by a central board, making the examination identical in conditions and character for the whole of Great Britain (and, if possible, for the Colonies also).

3.—A minimum of scientific training to be insisted on, and residence in a recognised scientific college to count up to, say, one-half of the apprenticeship required. At the same time a minimum of underground training to be also insisted on, say 3 years of each, for example.

4.—Every mine surveyor to hold a certificate of proficiency.

The writer ventures to think that these suggestions are neither very drastic nor very revolutionary, and is at the same time convinced that very much good would result from their adoption.

The late Professor C. Le Neve Foster, D.Sc., B.A., F.R.S., dealing with the training of mining engineers, wrote, "I am decidedly of opinion that students should have some practice at mines before attending lectures on mining. I can speak feelingly, for I know it was a great disadvantage to me not to have had some underground training before going to the Royal School of Mines."

## CHAPTER VIII.

## PREPARING FOR THE EXAMINATION.

"The greatest benefit which these examinations have conferred has been of an indirect character, for whereas previously a young man gained the practice afforded by his pit work, only in a few cases was it accompanied by that theoretical knowledge which is to be obtained from books. The pit shift being over in the morning, with perhaps a survey plotted in the afternoon, the newspaper or pipe filled up his remaining time; but with an examination to face, such subjects as geology, chemistry, and mechanics have to be thought about and studied, and when once the rudiments are acquired, in many cases a taste is awakened for information about which he otherwise would have known nothing. That which began in the nature of a school lesson becomes an absorbing recreation for perhaps a lifetime."—*A. L. Stevenson.*

The student should have at the outset in preparing for this examination a correct conception of the objects aimed at by the framers of the Coal Mines Regulation Act, in establishing a Board of Examiners in each district, and the issuing of certificates of the first and second class.

Each clause in the Act seems to have been specially framed, to secure the greatest safety possible for underground workers, to minimise the risks and casualties attendant upon mining operations, and to make a high standard of attainments essential to the holding of a certificate which will place a person in charge of a mine.

The examination is only a part of a necessary curriculum, through which the mining engineer has to pass, and the training essential to pass the examination successfully, places the student in a position whereby he can meet and explain to juries and deputations of workmen, with authority, what he considers the best methods of carrying on his works with safety, economy, and success.

The certificate, consequently, is a very valuable one, and as the lives of hundreds of men are frequently in the hands

of its possessor, the examiners very properly expect a high standard of proficiency from the candidate.

The candidate must be acquainted with the properties of air and gases, the various methods of sinking, opening out and working collieries, the mechanism of winding, hauling, pumping, and ventilating machinery, the breaking and working strain of ropes and beams, the best "first aid" to render in case of accident, the provisions and requirements of the Coal Mines Regulation Act, surveying, and other matters naturally expected to be met by a person in charge of a colliery.

To meet the requirements the candidate must also have spent a period of *five years* in a mine, where he will gain his practical experience, or three years together with two years at a recognised college course. He may receive *instruction* from books and papers, but his real mining *education* must be in the mine. The scientific principles underlying mining operations will be taught in evening classes or elsewhere, but the skill and tact indispensable to a successful conduct of the enterprise can only be gained at the colliery.

He should, therefore, at the commencement of his studies try and secure a position at one of the best equipped collieries in the district so as to gain his practical experience, visit other collieries at every opportunity that presents itself, and secure the services of a tutor who has been trained to teach—one who has made a study of psychology and mind training, so that he receives his instruction and education in due course.

Unfortunately, the period of apprenticeship is too frequently spent wholly in one mine, or where the student hardly ever comes across difficulties and disturbances such as he will possibly be expected to overcome when placed in charge of a colliery himself. Under these circumstances, and when the best books for mining students—the collieries of the district—are not available for his researches, he should master the excellent books now in the market on the various methods of conducting mining operations. Percy on "The Mechanical Engineering of Collieries," Pamely's "Colliery Manager's Hand Book," Foster's "Ore Mining," Hughes's "Text Book on Mining," Atkinson's "Mine Gases and Ventilation," Phillips on "Ore Deposits," Jamieson on "Steam and the Steam Engine," Brough on "Mine Surveying," Lyell's and Geikie's "Geologies," Roscoe's "Chemistry," he will find of invaluable service. The latest works on Electrical Engineering should also be carefully mastered.

But as the best books on these subjects, owing to the rapid progress made by engineering skill during the past decade, soon get "out of date," the student should carefully read the proceedings of the various mining and engineering institutes, and all the current literature available bearing on his studies. The *Engineer*, *Engineering*, *Colliery Guardian*, *Colliery Manager*, and *The Science and Art of Mining*, will each provide him with information and good descriptions of experiments with explosives, machinery, and other matters directly connected with his vocation. The Technical Instruction Classes held under the auspices of the various educational authorities throughout the country, conducted mostly by trained and experienced teachers, who will not only give him a "rule of thumb" method of proceeding with his work, but the best that modern skill and scientific research have been able to produce, he will also find of immeasurable advantage, and he should regularly attend them, if he has been unable to secure the advantage of a special course at a properly equipped science school or college.

The questions set at previous examinations will afford him a guide as to the ground covered by the examiners, and he will thus be able to gauge his prospects and decide whether it be advisable to send the necessary fee to the Home Office and arrange for the absence required from his duties, or postpone the test to a more fitting date. There is a great difference, as the candidate will readily perceive, between the standard of requirements in the various districts.

One of His Majesty's Inspectors of Mines in his annual report writes: "The publication of the questions for each district would on several grounds be distinctly advantageous, and would tend to bring about a more uniform standard, which is most essential; so much so, that I would advocate one central board of examiners." The suggestion is certainly an admirable one, and it is hoped it will soon be acted upon.

### AT THE EXAMINATION.

1.—Study the "real meaning" of the question. Too often the candidate, unable to answer the question set, writes an essay on some subject, with which he is better acquainted, and trusts the examiners will give him marks under the impression that he has misunderstood the meaning of the question. This plan will not succeed with the majority of examiners.

2.—Write short, concise, and pithy answers. You should not compel the examiner to wade through a mass of verbiage to search for what you have to say.

3.—Deal with the questions that seem easiest to you first, so that if you are pressed for time at the close, you will have omitted those you are doubtful of, and not the ones you are familiar with.

4.—Carefully apportion at the commencement a definite time for each of your answers, leaving ten or fifteen minutes at the close for revision and correction of errors.

5.—Illustrate your answers with sketches wherever possible.

6.—In arithmetic arrange your solutions neatly, taking enough room, cancelling if convenient, and showing all the "working" that the examiner may easily follow the various steps by which you arrive at your answer.

7.—Do not worry yourself on the examination morning by trying to "cram" facts and formulæ you should have mastered months previously.

8.—Do not try to introduce clandestinely books or papers into the examination room that you may "copy" some of your answers. On several occasions this dishonesty and meanness has ended disastrously, and the candidate debarred from being re-examined for two or three years.

9.—Do not attempt to make an ostentations display of your knowledge by using long words of whose meanings you are doubtful, when short plain words are convenient and suitable.

10.—When asked for the size of engines—hauling, pumping, winding, &c.—the dimensions of the engines at your own and neighbouring collieries should form a guide to prevent a totally unsuitable answer being given.

## CHAPTER IX.

## STATISTICS.

A faint idea of the importance of the duties of the mining engineer may be obtained from the following statistics with regard to the output of coal:—

COAL PRODUCTION IN THE FIVE PRINCIPAL COAL-PRODUCING COUNTRIES OF THE WORLD IN 1900, 1901, 1902.

| | 1900. *Tons.* | 1901. *Tons.* | 1902. *Tons.* |
|---|---|---|---|
| United Kingdom ..... | 225,181,000 | 219,047,000 | 227,095,000 |
| Germany ..... | 109,290,000 | 108,539,000 | 107,436,000 |
| France ..... | 32,722,000 | 31,634,000 | 29,574,000 |
| Belgium ..... | 23,463,000 | 22,213,000 | 22,769,000 |
| United States ..... | 240,788,000 | 261,874,000 | 268,688,000 |

Tons of 2,240 lb.
Metric tons of 2,204 lb.
Provisional figures.

It will be seen that less coal was produced in 1902 in Germany and France than in either of the preceding years. The quantities produced in the United Kingdom, the United States, and Belgium were greater than in 1901, and in the first two countries exceeded those produced in any previous year. The production of Germany represents less than half, and that of France and Belgium together less than a quarter of the production of this country.

The total known coal production of the world (exclusive of brown coal or lignite) is now about 700 million tons (of 2,240 lbs.) per annum, of which the United Kingdom produces rather less, and the United States rather more, than a third.

As compared with its population, the production of coal in the United Kingdom still surpasses that of the United States. It amounted to $5\frac{1}{4}$ tons per head of the population in 1901, and $5\frac{1}{2}$ tons per head in 1902, whilst in the United States it is still only just over $3\frac{1}{2}$ tons per head. In Belgium it also amounts to about $3\frac{1}{5}$ tons per head, in Germany to rather less than 2 tons per head, and in France to about $\frac{3}{4}$ ton per head

The following statement shows the average value per ton of the coal produced taken at the collieries, in the five above-mentioned countries, in the year 1901 :—

| | *Per ton.* s. | d. |
|---|---|---|
| United Kingdom .. .. .. | 9 | 4¼ |
| Germany .. .. .. .. | 9 | 4¼ |
| France .. .. .. .. | 12 | 7½ |
| Belgium .. .. .. .. | 12 | 2¼ |
| United States .. .. .. .. | 5 | 6½ |

These prices represent a fall of about 1s. 6d. per ton in the United Kingdom, and 1s. 9d. per ton in Belgium, but a rise of 6d. per ton in Germany, 7d. per ton in France, and 3d. per ton in the United States.

The number of persons employed in the mining industry in the United Kingdom for the year 1905 was 858,373.

The deaths from accidents for the same year reached 1,150 ; this figure works out at 1·34 per 1,000 persons engaged above *and* underground, or 4·6 per 1,000,000 tons of coal raised.

Sir James Joicey, M.P., writing to the *Times*, gives some interesting figures bearing on the profits of coal-mining, from which the following are extracted :—

The consumption of coal in some of the chief consuming countries is shown in the following statement, in which the countries are given in the order of importance as coal consumers :

| | 1901. *Tons.* | | 1902. *Tons.* |
|---|---|---|---|
| United States ..... | 256,407,000 | .. | 265,105,000 |
| United Kingdom ..... | 161,271,000 | .. | 166,698,000 |
| Germany ..... | 97,436,000 | .. | 95,325,000 |
| France ..... | 44,651,000 | .. | 42,199,000 |
| Russia ..... | 19,913,000 | .. | — |
| Belgium ..... | 18,951,000 | .. | 19,691,000 |
| Austria-Hungary ..... | 18,493,000 | .. | — |

Provisional figures.

It will be seen from these figures that the total consumption of coal in the United States surpasses that in any other country. As regards consumption of coal per head of population, however, the United Kingdom still takes the lead, as appears from the following statement, which applies to 1902 :—

| | *Tons.* |
|---|---|
| United Kingdom .. .. .. | 3·97 |
| United States .. .. .. .. | 3·36 |
| Belgium .. .. .. .. | 2·86 |
| Germany .. .. .. .. | 1·65 |
| France .. .. .. .. .. | 1·08 |
| Austria-Hungary .. .. .. | 0·40 |
| Russia .. .. .. .. .. | 0·15 |

Tons of 2,240 lb.
Metric tons of 2,204 lb.
In 1901.
Provisional figures.

In the Mons district in Belgium some colliery shafts have already reached a depth of 3,775 feet. Though the coal is excellent, the hindrances to mining are many and almost insuperable. There are many blowers of gas and water at 122° F. It has also been found necessary to replace the ordinary wooden timbering by steel props.

At Pendleton (Manchester) coal is worked from a depth of 3,500 feet. At Abercynon (South Wales) from a depth of 2,220 feet, Deep Navigation, Treharris, 2,235 feet.

In 1829 the cost of sinking a mine shaft reached from £10,000 to £15,000. In 1857 no less than £40,000 was spent on a shaft at the Haswell Colliery in the county of Durham, in contending with the quicksands, and even then the shaft had to be abandoned. At Minton Colliery, a few miles distant from Haswell, £300,000 was expended in sinking; the quantity of water pumped during the operation of sinking through the overlying magnesian limestone averaged 9,300 gallons per minute from a depth of 540 feet.

| | |
|---|---|
| Tons of coal drawn for fifteen years (1886-1900).. | 2,802,395,000 |
| Value at pit's mouth .. .. .. .. | £953,477,000 |
| Average value per ton .. .. .. .. | 6s. 9·65d. |
| Expenditure on wages .. .. .. .. | £642,386,000 |
| Remaining over for expenses other than wages,&c. | £311,092,000 |

The other expenses would include, *Materials* of all kinds, including horse provender (but exclusive of coal for colliery consumption) about 7½d. *Rents:* These were estimated to be 5½d. in 1889 by the Royal Commission Sales Department, salaries, rates, Compensation Act, and sundry expenses about 6d., making a total of 1s. 8d. per ton (when royalty, as is often the case, is taken at 6½d.).

The total receipts may then be divided thus:—

| | £ | | *Per ton.* |
|---|---|---|---|
| Rents ..... .. | £75,904,000 | .. | 0s. 6·50d. |
| Wages ..... | 642,386,000 | .. | 4s. 7·01d |
| Materials, &c. .... | 157,646,000 | .. | 1s. 1·50d. |
| Profit ..... | 77,542,000 | .. | 0s. 6·64d. |
| | £953,478,000 | .. | 6s. 9·65d. |

In the majority of cases coal mines yield, with their great risks, an interest which on an average yields only that secured by Consols. Many lose their money altogether, and a few make large fortunes.

## UNITED KINGDOM RETURNS FOR 1905.

TABLE SHOWING THE NUMBER OF PERSONS EMPLOYED AT MINES UNDER THE COAL MINES ACT, THE OUTPUT OF MINERAL, AND THE DEATH-RATE, CLASSIFIED ACCORDING TO INSPECTION DISTRICT. YEARS 1904-05.

| | *Persons employed.* | | *Output of minerals in tons.* | | *Output in tons per person.* | | *Total number of deaths from accidents.* | | *Death-rate per 1,000 persons employed.* | | *Number o deaths per 1,000,000 tons of mineral raised.* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTRICT. | 1905. | 1904. | 1905. | 1904. | 1905. | 1904. | 1905. | 1904. | 1905. | 1904. | 1905. | 1904. |
| East Scotland..... | 57,064 | 55,429 | 20,847,673 | 19,976,448 | 365·3 | 360·3 | 65 | 72 | 1·13 | 1·29 | 3·113 | 3·604 |
| West Scotland ..... | 57,230 | 57,340 | 19,417,483 | 19,797,921 | 339·3 | 345·2 | 75 | 91 | 1·31 | 1·58 | 3·86 | 4·59 |
| Newcastle ..... | 93,227 | 90,650 | 27,614,352 | 26,727,565 | 296·2 | 294·8 | 87 | 93 | ·93 | 1·02 | 3·15 | 3·479 |
| Durham ..... | 93,619 | 91,291 | 31,186,980 | 30,225,348 | 333·1 | 331 | 88 | 107 | ·94 | 1·17 | 2·82 | 3·54 |
| York and Lincoln ... | 112,711 | 112,105 | 30,489,999 | 29,383,391 | 270·5 | 262·1 | 124 | 131 | 1·10 | 1·16 | 4·06 | 4·458 |
| Manchester & Ireland | 45,895 | 45,955 | 11,778,398 | 11,627,804 | 256·6 | 253 | 27 | 51 | ·58 | 1·11 | 2·29 | 4·38 |
| Liverpool & N. Wales | 61,559 | 61,785 | 15,762,964 | 16,233,740 | 256 | 262·7 | 80 | 77 | 1·29 | 1·24 | 5·09 | 4·74 |
| Midland ..... | 103,482 | 102,488 | 31,196,791 | 29,920,955 | 301·4 | 291·9 | 89 | 86 | ·86 | ·839 | 2·21 | 2·874 |
| Stafford ..... | 54,845 | 54,617 | 15,734,777 | 15,553,559 | 286·9 | 284·7 | 67 | 68 | 1·22 | 1·24 | 4·26 | 4·372 |
| Cardiff ..... | 86,881 | 85,610 | 22,469,799 | 22,879,788 | 258·6 | 267·2 | 287 | 137 | 3·303 | 1·61 | 12·7 | 5·9 |
| Swansea..... | 37,500 | 37,000 | 9,947,671 | 9,752,546 | 265·3 | 263·5 | 75 | 61 | 2 | 1·65 | 7·54 | 6·254 |
| Southern ..... | 54,360 | 53,283 | 13,333,307 | 13,696,250 | 245·3 | 257 | 86 | 81 | 1·58 | 1·52 | 6·45 | 5·9 |
| Grand Totals ... | 858,373 | 847,553 | 249,780,194 | 245,775,315 | 291·9 | 289·9 | 1150 | 1055 | 1·34 | 1·24 | 4·6 | 4·3 |

## Chapter X.

## EQUIPMENTS OF A MODERN COLLIERY.

The candidate for a certificate as Colliery Manager may glean from the following account of the equipments of a newly-opened colliery at Bargoed in South Wales, something of the essentials of a mining engineer's training.

Briefly reviewed, the work of sinking the colliery was commenced as far back as April, 1897, and the "Ras Las" or "Nine Feet" seam was reached at a depth of 625 yards in November, 1901. The area to be worked amounts to about 2,400 acres, and is leased from ten different owners, the largest area being the property of Lord Tredegar, and on this the shafts are situated. The site is, unfortunately, narrow, and has necessitated the laying out of the various works in a long narrow line. The River Rhymney, which runs through the centre, and divides Glamorgan and Monmouthshire, added considerably to the expenses. The colliery has direct communication with the Brecon and Merthyr, the Rhymney, and the Barry railways, thus getting access to Newport, diff, Penarth, and Barry. The two steam coal shafts are feet in diameter, the sinking contract for which was entrusted to Messrs. I. Pigott and Sons, and the first important seam met with is that variously known as the "Brithdir" or "Pontygwaith," or "Tillery," and is a "house" and coking coal. It lies at 200 yards depth, and is approximately 4 feet thick. Six different feeders of water were met with at the depth of 80, 210, 280, 350, 490, and 540 yards respectively, and the main pumps go down to a point below the last mentioned at 545 yards. The pumping engine is by Hathorn, Davey, and Co., compound differential horizontal, 44 inches and 76 inches diameter of cylinders, and 10 feet stroke, acting direct upon balanced quadrants and pump-rods; the upper lifts are 192 yards and 17 inches diameter, the middle 162 yards and 14 inches diameter, and the lower 188 yards and 10 inches diameter.

The total of the different feeders was about 72,000 gallons per hour, but some having considerably diminished after a time, the quantity of water raised is now about 38,000 gallons. After passing through several seams of coal, the "Ras Las"

was selected to form the pit bottom in, and it is intended to develop these lying overhead, viz.: the "Upper Four Feet," the "Six Feet," and the "Red" coal. The analysis of the "Ras Las" is as follows:—Fixed, 80·22; ash, 2·88; volatile, 16·24; moisture, 0·66. No less than 2,223 tons of coal have been raised in one day and 8,500 tons in a single week. The winding engine at the South Pit is a four-cylinder compound, built by Thornewill and Warham, with two horizontal cylinders, 32 inches diameter and 6 feet stroke, and two low-pressure vertical cylinders, placed directly below the cranks, 50 inches diameter and 6 feet stroke. It will also be provided with Korting condensers, the water for which will be raised from the river by a Laval steam turbine driving a centrifugal pump. The winding drum is of the modified conical form designed to facilitate rapid starting without unduly increasing the inertia to be overcome. The cages have two decks, and, having two trams on each deck, four trams, containing about 5 tons 12 cwt. of coal will be raised. The top and bottom of the shaft are arranged for simultaneous loading and unloading, and, therefore, the winding capacity will be between 300 and 350 tons per hour. The shaft is fitted with rail guides. The ventilation is produced by a Walker fan, 30 feet diameter, by 9 feet wide, driven by a two-cylinder vertical compound engine by the same makers, and is capable of producing 400,000 cubic feet of air per minute at an pressure of 21 lb. per square foot. It is intended to use co pressed air for hauling the coal for a time, and later on to introduce electric power, and reserve the compressed air for such positions as may not be thought suitable and safe for the employment of electricity. A large air-compressor has, therefore, been installed on the King principle, and with Riedler valve gear, built by Messrs. Fraser and Chalmers. The engine is double vertical and compound in both the steam and air portions. A separate shaft 18 feet in diameter has been sunk to the Brithdir Seam, and is being equipped for an output of 1,000 tons per day. There is a large area of the shaft reserved for pumping, as the seam is notable for the quantities of water it produces. For winding there is a pair of 20 by 36 engines, but one cylinder will be replaced by a 32-inch diameter low pressure, and the engine used as a compound as soon as regular winding commences. A 300 h.p. Marshall engine of the horizontal compound class drives three dynamos and provides power for lighting, and also for driving the workshops, mortar mill, horse feed machinery, various creepers, motors

working the screens, &c. The steam supply is provided by sixteen Babcock boilers at 100 lb. working pressure, and is superheated. The safety lamps in use are electrically locked, lighted, and opened, and the lamp-room is built for accommodating 2,200 lamps. A central engineering establishment for repairs needed at the group of collieries belonging to the company in the Rhymney Valley is being erected, consisting of pattern shop, foundry, fitting shop, and smithy. A coal washery of a capacity of 1,200 tons per day, and for 50 by-product coke ovens have also been erected.

The Powell Duffryn Company, it may be added, is the largest colliery concern in South Wales at the present time. The annual output is close upon three million tons. About 9,000 men are employed, and the "takings" of the company cover in all about 15,000 acres, 5,000 of which are in the Rhymney Valley and 4,000 in the Aberdare Valley. The new Bargoed Colliery will give employment to 1,250 men, and the output is expected to reach about 350,000 tons per annum. The company is now building about 500 workmen's cottages, a large number of which have already been completed, while many of the cottages are being erected by building societies. These will not suffice to meet the needs of the district, and many more dwellings will have to be built. The winding engine, built from special designs prepared by the Agent, Mr. E. M. Hann, is capable of raising 3,000 tons a day, and almost the entire quantity of coal produced will be exported.

# CHAPTER XI.

## BOARD OF EDUCATION

### EXAMINATION QUESTIONS FOR FIFTEEN YEARS, ARRANGED AND CLASSIFIED.

### GEOLOGY.

1. What are the general characters of the deposits in which the following minerals are found —
   (*a*) Coal. (*b*) Salt. (*c*) Tin ore ?
2. What is the relation between the ore-bearing quality of lodes and the country rock ? Give some examples.
3. What peculiarities are observed in mineral deposits in limestone rocks ? Give examples.
4. What is a coal seam ?
5. What is a lode, and how do metallic ores occur in it ?
6. What are true veins, segregated veins, and contact deposits ? Give an example of each.
7. What kinds of coal are found in the Carboniferous strata of Great Britain, and how do they differ from each other ?
8. What is a lode or mineral vein ?
9. What minerals are usually found in stratified deposits ?
10. Define the terms—fault, throw, hitch, and heave, as used by miners.
11. What are the principal kinds of mineral deposits ? Give an example of each.
12. In what formations are coals found besides the Coal Measures ? Do such coals differ from those of the Carboniferous period ?
13. How is the position of a coal seam determined in a royalty before commencing to work it ?
14. What is meant by the expression—*a true fissure vein*, and how does such a vein differ from other kinds ? Give some examples.
15. What are clayband ironstones, how do they occur, and what methods are adopted for working them ?
16. What are mineral veins, and by what other names are they known in different districts ?
17. How are the ore bodies generally distributed in a vein with regard to the rocks forming the walls ? Give examples in support of your answer.

18. How is a coal-field proved as a preliminary to working it ?
19. What is cannel coal, and under what conditions is it generally found ?
20. What is a mineral vein or lode, and what special terms are used in describing it ?
21. What are the different kinds of coal, and how do they differ from each other ?
22. What are veins and beds of minerals, and how do they differ ?
23. How is coal found, and what are the terms used to describe—
    (*a*) The character of the deposits ?
    (*b*) The interruptions and disturbances to which they may have been subjected ?
24. Enumerate the different kinds of deposits in which useful minerals are found ?
25. How is coal found, and with what minerals is it generally associated ?
26. Describe the general stratigraphical features of the Lanarkshire coal-field, and the methods of working followed.
27. Define the terms seam, vein, measures, hade, dip, underlie, dyke, slip, cross-course, slide, shode, costean.
28. Give an account of the Cleveland iron ore, and the methods adopted in working it.
29. What are minerals, as the term is understood by miners ?
30. Describe the general structure of a coal-field.
31. With what rocks and minerals is coal usually associated ?
32. Describe the principal features of the Cardiganshire and Mid-Wales lead mines.
33. Give an account of the Somersetshire coal-field, and of its relation to the carboniferous strata east and west of it.
34. What are mineral veins and beds, and what other terms are used for their description ?
35. What is coal, and how is it found ?
36. What relations have been observed between the ore-bearing quality of lodes and the character of the containing or "country" rock ? Give examples in support of your answer.
37. What are the different kinds of deposits in which metallic minerals are found ?
38. What are *cannel*, *hard steam coal*, and *anthracite*, and where are they chiefly found in the United Kingdom ?
39. How is the ore distributed in the tin lodes of Cornwall ? With what minerals is it associated, and how does the productive character of the lode vary with changes in the country ? Give an example specifying the locality.

40. What is a gozzan, and what kinds of minerals are usually found in it? Give examples from silver, copper, and lead ore lodes.
41. What are lodes, beds, and cross-courses?
42. What kinds of ore deposits are known besides beds and lodes?
43. What are coal, bituminous shale, and ganister?
44. How is the throw of a fault proved in a coal mine?
45. What are the minerals known as red and brown hematite?
46. How is the ore-bearing character of lodes affected by changes in the containing rocks or *country?* Give some examples.
47. What are the principal kinds of deposits in which minerals are found?
48. What are faults and cross-courses?
49. What minerals are usually found together with coal? Which are valuable, and which are likely to injure it?
50. What relations are observed between lodes and cross-courses that intersect? Give some examples.
51. Describe the general mining characters of the lead mining district of Alston Moor.
52. Describe the more important localities producing manganese ore.

---

## PROSPECTING AND SINKING.

1. Give a sketch of the operation followed in proving a coal-field by boring.
2. Describe a method of deep boring in which the detritus is discharged continuously.
3. How is a coal-field proved as a preliminary to working it?
4. Describe the methods of tubbing shafts with segmental rings of wood and cast iron, giving illustrations with dimensions.
5. What is the principle of Darlington's boring machine?
6. Describe the tools necessary for boring or drilling in hard rock.
7. How is the sinking of a shaft conducted when the upper part is in use for drawing minerals?
8. How would you collar up a shaft near the surface in moderately firm ground?
9. What kind of steel do you prefer for blasting drills, and how do you sharpen and temper them?

10. What forms of cutting edges are best adapted for borers intended for use—
    (*a*) In soft ground by hand power ?
    (*b*) In hard ground by machine power ?
11. How would you sink a small shaft, of either circular or rectangular section, using timber to secure it ?
12. Describe with sketches the construction of the horse whim or gin.
13. Describe the operations of sinking a shaft and securing it with brickwork.
14. Describe a boring-machine and appliances suitable for driving or sinking in hard ground.
15. Give the dimensions of a borer or drill suitable for boring in hard rock, and describe the method of sharpening and tempering the bit.
16. How would you put down a deep boring for coal or salt ?
17. Describe and illustrate the use of timber in securing a round or rectangular mine shaft.
18. Describe Poetsch's method of shaft sinking.
19. What is meant by proving a coal-field ?
20. Describe two methods of deep boring.
21. Describe a method of sinking where tubbing is required.
22. Describe the Kind-Chaudron system of shaft sinking.

---

### Practical Working.

1. Describe the methods of working and tramming minerals from a lode by overhand stoping.
2. What precautions are necessary in driving towards old workings ?
3. How can steel or iron be used instead of timber under ground ? Give some examples.
4. Describe the South Wales method of working coal by single and double stall.
5. Describe and sketch a common method of timbering a level.
6. What is the order of operations in getting coal ?
7. How is black tin produced from tin stuff ?
8. Describe a long wall method of working a seam with a high dip.
9. Describe the method of overhand stoping on a large lode.
10. What changes in quality and regularity of position are found in working coal seams ? Give examples.
11. How are levels secured in soft ground by timber, iron, or steel ? Give examples in detail.

12. What are jigs and cage dips ? Give an example of each.
13. Give an account of the South Staffordshire coal-field, distinguishing the position, thickness, aud quality of the chief seams, and the method of working generally followed.
14. How would you lay out the roads for hauling coals underground in a long wall working upon a 5-feet seam dipping 1 in 12 from the pit bottom ?
15. How is a mine upon a lode laid out for working ?
16. What is the pillar and stall method of coal working, and by what other names is it known ?
17. Describe the method ot underhand stoping.
18. What is the best method of working a thin coal or other stratified mineral ? Illustrate your description.
19. What methods have been proposed for breaking down coal without the use of gunpowder ?
20. Describe the method of securing a level by complete elliptical masonry.
21. Describe, with figures, the method of working a mineral deposit by overhand stoping.
22. Describe a method of working a highly inclined coal seam.
23. How may the workings on a large mineral vein be secured without timber ?
24. How is a mineral vein wrought by overhand stoping ? Give details of the method of securing the ground and passing the broken stuff down to the level below.
25. Describe two methods of long wall working suited for flat and inclined seams respectively.
26. Give a sketch of the method of timbering a level in moderately hard ground.
27. Describe the Barnsley method of working coal.
28. Describe the use of power wedges and the lime cartridge in breaking down coal.
29. How is slate mined in North Wales ?
30. How is coal brought from the working face to the pit bottom in flat and inclined seams respectively ?
31. Describe the method of working the thick coal of South Staffordshire.
32. What precautions are necessary in driving towards old workings filled with water ?
33. How are the workings of mines represented on plans ?
34. Explain two methods of securing levels in flat lodes when both walls are tender.
35. What changes are observed in coal seams near faults or troubles, and how are workings laid out in faulted ground ?

36. How do you drive or secure a level or stone drift ?
37. Describe in detail some form of coal cutting machine ?
38. How is coal handled between its arrival at bank and its discharge into the railway waggon ?
39. What precautions are necessary in driving towards old workings filled with water ?
40. Give an account of a method of working a thick coal with a bad roof.
41. What is the method usually adopted for finding the continuation of a coal seam that has been broken by a fault ?
42. What are the best methods of preserving timber underground ?
43. What are the principal methods in use for signalling from the bottom of a deep mine to the surface, and of indicating the position of the cage or skip ?
44. Give a sketch of the pit-top arrangement of a large colliery where the coal is screened and loaded into railway waggons.
45. How is the durability of timber underground affected by the atmosphere, and what methods have been adopted for its preservation ?
46. How is compressed air obtained for use underground ?
47. A lode 4 feet wide is filled solid with quartz, enclosing a mixture in equal volumes of copper and iron pyrites equal to a solid rib of 10 inches thick. What are the weights in cwts. per square fathom—
    (*a*) Of the whole lode ;
    (*b*) Of the pyritic minerals cleaned from quartz ; and
    (*c*) What produce for copper do the latter represent ?
48. A vein contains lead ore equal to a rib $\frac{1}{4}$-inch thick of solid galena. What weight of ore does this give per fathom ?

---

### Gases and Ventilation.

1. What gases are met with in coal mining, and in what kind of coal are they most dangerous ? Give examples in illustration of your answer.
2. Describe the arrangements of an upcast shaft where an underground ventilating furnace is used.
3. When is artificial ventilation necessary in mines, and how is it produced ?
4. What principles are involved in the artificial ventilation of mines ?

5. What volume of fresh air should be provided per minute in a colliery for each man employed underground ?
6. What is the effect of fire-damp upon the flame of a safety-lamp, and what other methods of testing the air of mines for inflammable gas have been proposed ?
7. How can a level be ventilated when it is beyond a main air-way ?
8. How is the amount of air passing through the workings of a colliery determined ?
9. What dangerous and deleterious gases are likely to be met with in working coal or metal mines respectively ?
10. Describe the contrivances necessary for splitting and coursing air-currents underground.
11. Describe the anemometer and water-gauge, and show how they are applied to determine the efficiency of ventilation.
12. How is the air of a mine tested for fire-damp ?
13. Describe the construction of an underground ventilating furnace.
14. How is air carried to the forebreast of a level ?
15. What methods are generally adopted for ventilating the ends of workings in mines ? Give examples, with sketches, either from coal or metal mines.
16. How can compressed air be most economically applied to ventilation ?
17. When fire-damp is burnt with air explosively, what is the nature of the products of combustion ?
18. What amount of fresh air should be provided per minute for each man, horse, and lamp in a colliery ?
19. Explain the use of the water-gauge and anemometer in controlling the ventilation of a colliery.
20. What is fire-damp, and how is it dangerous in mines ?
21. How is a furnace used in ventilating mines ?
22. How is the ventilation of the forebreast of a level effected ?
23. Describe the methods adopted for splitting, regulating, and crossing air-currents in a large mine.
24. Describe the Fleuss apparatus.
25. Describe the Capell and Guibal fans.

---

### LIGHTING.

1. What is a safety-lamp ?
2. Describe the Mueseler safety-lamp ?
3. Describe the safety-lamp in one of the original forms, and discuss some of the newer modifications.

4. What is the principle of safety-lamps, and how far are they safe? Describe and illustrate two kinds.
5. Describe in detail the construction of a Davy lamp.
6. Give particulars of the construction of any two of the following lamps:—Marsaut, Morgans, Clanny.
7. Describe in detail the Pieler lamp.
8. How does the Stephenson differ from the Davy lamp?
9. Describe two fire-damp detectors with which you are acquainted.
10. Describe the Cambrian and Thornbury lamps.
11. How does the velocity at which the air is travelling interfere with a safety-lamp?

---

### Mining Tools.

1. Describe, with sketches, two kinds of picks suited for driving in coal and stone respectively.
2. What tools are included in a double-handed set of blasting gear used in vein mining?
3. Give the forms and dimensions, with sketches to scale, of borers, or drills suited for driving in hard and soft ground respectively.
4. Describe the picks used in some coal or metal mining districts, stating the district, and giving sketches with figured dimensions.
5. Describe, with sketches, the tools required in double-handed blasting?
6. How would you sharpen and temper the bit of borer for boring by hand in rock? What shape and dimensions would you prefer?
7. Describe, with sketches, the tools required for—
   (*a*) Hewing coal on a long wall face;
   (*b*) Driving a level in a mineral vein.
8. Describe two kinds of picks used in coal and metal mining, giving figures and dimensions.
9. Give the shape and dimensions of a borer or drill suitable for boring in hard rock, and describe the method of sharpening and tempering the bit.
10. Describe, with discussion of details of construction, some form of boring or drilling machine, either percussive or rotatory.
11. Describe, with sketches, two kinds of collier's picks.
12. Describe the tools required for double-handed boring in hard rock.

13. Describe a "simple" windlass with brake for use underground.
14. How should ladders be arranged for safety and convenience in a footway shaft?
15. How is a borer sharpened and tempered for use in hard rock?
16. Give a sketch and description of a windlass for hoisting by hand in a winze.

---

## EXPLOSIVES.

1. What are dynamite and guncotton, and how do they differ in their action?
2. What rules are best calculated to prevent accidents from explosives, and in blasting, underground?
3. What are the composition and relative value of the explosives known as Extra Strong Mining Powder, Lithofracteur, and Tonite.
4. Of what is dynamite made, and how is it used?
5. What methods have been proposed for breaking down coal without the use of gunpowder?
6. What is the construction of safety fuse, and how is it used with gunpowder and dynamite respectively?
7. How are gunpowder and dynamite used in mining?
8. What are the principal nitro-compounds useful as mining explosives?
9. Describe the use of power wedges, and the lime cartridge in breaking down coal.
10. Give an account of the methods of electric blasting.
11. Mention the different kinds of explosives used in mining, giving the composition of some of them

---

## DRAINAGE.

1. How are mines kept free from water?
2. How is water raised from a deep mine without pumps?
3. Give an account of an underground pumping engine.
4. What is the cause of acid water in mines? Can such water when neutralised by lime be used for feeding boilers?
5. At what rate will it be necessary to work a 12-inch pump of 9-feet stroke to keep down a flow of 200 gallons of water per minute in a shaft 200 yards deep, and what approximate H.P. will be required?
6. Describe, with sketches, the principle of construction of the plunger pump.

7. Describe the arrangement of the pumping engine and pit work in a deep mine.
8. What is the cause of acid water in mines, and how are pumps protected against its action ?
9. Give an account of a double-acting compound steam engine suitable for pumping from a deep mine.
10. Describe, with sketches, the construction of a single-acting plunger pump with plain flap valves.
11. What are the special advantages and disadvantages of steam pumping engines placed underground ?
12. Give a description and figure of the bottom lift of a deep mine pump.
13. Describe the usual arrangements of the pit work of a deep mine where a steam pumping engine at the surface is used.
14. Describe a form of timber dam for keeping back water in a level or drift.
15. Describe the arrangements on the outdoor side of a Cornish beam engine pumping in a vertical shaft.
16. How are the lifts arranged in a deep mine pumping engine ?

## Haulage.

1. How should steel wire drawing ropes be handled when in use to prevent accidents from sudden breakage ?
2. What is meant by negative load upon a winding engine, and how is it counteracted ?
3. What is the best way of managing wire pit ropes to ensure regular wear and safety ?
4. What arrangements have been adopted to prevent accidents from over-winding ?
5. Of what materials and forms are the ropes and chains used in deep mining generally made ?
6. Describe the method of endless rope-hauling in two modifications.
7. What is Kœpe's system of winding ?
8. How are minerals drawn up an inclined shaft ?
9. Describe two kinds of safety catches.
10. What is a safety load for a steel pit rope, and how should such a rope be protected in use ?
11. Describe, with detail sketches, the construction of a skip-rope in an inclined shaft.
12. Describe the endless chain system of haulage in levels.
13. What different kinds of drawing ropes are used in mines ?

14. Describe the different methods employed in gearing rope drums to winding engines, giving sketches of an example with figured dimensions.
15. How would you arrange an engine of small size both for drawing mineral and pumping water, supposing it to be required only a few hours daily ?
16. How may the Cornish skip be modified for use in raising and lowering men ?
17. Describe the main and tail rope system of haulage ?
18. Describe the construction of the man engine with and without hydraulic balance.

---

### COAL WASHING AND TREATMENT OF ORES.

1. What are the most approved methods of washing coal slack ?
2. Describe the Berard coal washing machine and some of its newer modifications.
3. Give an outline of the methods of separating lead and blende ores from sparry vein stuff.
4. What plant is required to dress 30 tons of tin ore per month from stuff yielding 2 per cent. of black tin ?
5. Describe the method of dressing mixed lead and blende ores.
6. Describe the Brunton frame and Frue vanner.
7. What method has been proposed for separating pyrites from blende founded upon their difference of hardness ?
8. What is a convenient number of sizes to make in dressing mixed lead and blende vein stuff, and what is the finest size suitable for treatment on the jigging machine ?
9. How are rolls and stamps used for crushing minerals ?
10. Describe some machines for saving ores from fine slimes, working continuously.
11. Describe a continuous self-acting jigging machine.
12. Describe the process of dressing tin-stuff for black tin.
13. How can galena and zinc blende be separated, and how is the process affected by iron pyrites in the vein stuff ?
14. Give an account of the method of dressing lead ore when a portion of the vein stuff requires grinding.

## SCIENCE AND ART DEPARTMENT EXAMINATIONS.

### Honours, 1892.

1. What are the principal districts producing tin ore at the present time? Give detail as to the nature of the deposits and the minerals produced.
2. What are the principal unconformities observed between the coal measures and newer strata? State the bearings of this question upon the existence of possible new coal-fields in England.
3. Describe the American method of securing large excavations with specially prepared square timbers.
4. Describe the Chaudron system of boring and tubbing shafts, both with and without a moss box.
5. Describe the arrangements of a colliery shaft fitted to draw 800 tons in 10 hours from 300 yards depth.
6. How would you arrange the pump rods in a shaft of varying slope where there is a change of 30 degrees in the inclination from the vertical?
7. Discuss some method of transferring power from a vertical water-wheel to a shaft 150 yards distant.
8. Give an outline of the operations in the treatment of auriferous quartz when it is desired to save a proportion of pyrites and other sulphides.

### 1891.

1. What are the most important districts producing copper ores at the present time? Give details of the nature of the deposits, and the character of the minerals produced in each district.
2. What are the qualities required in a steam coal for navigation purposes? Where are such coals produced in the United Kingdom, and how are they prepared for sale?
3. Describe some methods of working large mineral deposits where filling or packing with rock is used.
4. What are the principal kinds of air compressors used for mining purposes?
5. Describe the principal methods used in working deposits of rock salt.
6. Give an account of some of the principal water-pressure pumping engines at work in deep mines.

7. What is the Luhrig system of coal washing ?
8. What is the Huntington quartz mill, and what advantages are claimed for it over stamps ?

1890.

1. Describe the Yorkshire and Derbyshire coal-field.
2. What are the most important silver-producing districts of the world at present ? Indicate the kinds of mineral produced in each district.
3. Describe a method of sinking and tubbing a shaft in very watery ground, either with or without pumping.
4. Give a sketch of a coal working, long wall, or pillar and stall, supposing a thin seam dipping about 15 degrees, indicating air-courses, drawing roads, and other necessary details.
5. Give an account of an installation for producing and distributing compressed air underground.
6. Describe any two of the following ventilating fans :— Guibal's, Pelzer's, or Capell's.
7. What methods are adopted for counter-balancing and utilising the excess weight of the water in a single-acting pump-engine ? Describe some of them in detail.
8. Describe some of the newer machines for fine grinding or pulverising minerals.

1889.

1. Describe the South Wales coal-field, and notice the other basins on the same axis.
2. Describe the more important centres of production in the iron ore districts of the secondary formations in England and on the Continent of Europe.
3. How are wrought iron and steel used instead of timber in shafts and levels ? Give some examples and illustrations.
4. Describe a method of working a thick and highly inclined coal seam in which the excavated ground is filled with waste from the surface.
5. Give an account with details of construction of a modern pit frame in iron or steel.
6. Compare Guibal's and Wardle's ventilating fans.
7. What methods have been proposed to prevent flame in the use of explosives in collieries ?
8. How have magnets been applied in the separation of zinc blende from spathic iron ore ?

1888.

1. Give an account of the Northumberland and Durham coal-fields, including the lower Carboniferous district.
2. What are the most important copper-producing districts at the present time? Describe one or two of them in some detail.
3. What methods have been proposed for driving, sinking, and getting minerals in mines without the use of explosives?
4. What is the effect of coal-dust on the atmosphere of fiery mines, and what special precautions are required in working such mines?
5. Describe and illustrate the method of dividing a circular shaft into compartments for drawing, pumping, and footways, or a rectangular shaft giving similar accommodation.
6. It is required to raise 250 gallons of water per minute from a mine 350 yards deep. Give a general idea of the plant that you would prefer for the work.
7. How is coal cleaned from shales, &c., before coking?
8. Describe the principal kinds of stamping mills used for crushing minerals.

1887.

1. Give an account of the South Wales coal basin, with details as to the nature, distribution, and method of working the principal seams.
2. Give an account of the distribution and association of tin ore in the more important tin producing countries.
3. What methods have been used to determine the deviation of bore-holes from the vertical?
4. What power and appliances would you consider necessary for drawing 600 tons of coal in 10 hours from a pit 400 yards deep? Give some of the leading dimensions of plant (engines, boilers, &c.) that you would prefer.
5. What arrangements are necessary for renewing the wearing parts of mine pumps, and generally for keeping the pit-work in order.
6. What methods have been proposed for penetrating into mine workings when the ventilation is stopped?
7. Describe the construction of Darlington's or some similar boring machine.
8. What methods are adopted in the treatment of auriferous vein quartz containing a small quantity of sulphides, when the latter is to be saved?

1886.

1. Give an account of the North Staffordshire coal-field.
2. Give an account of the principal European lead mining districts.
3. Describe a method of putting down a shaft through quicksand without the use of pumps.
4. Describe two forms of centrifugal ventilators suitable for collieries, giving details of construction and of their mechanical efficiency.
5. How has electricity been applied to underground haulage ?
6. Describe the construction of a pumping engine driven by the pressure of a column of water.
7. Give an account of the plant and machinery required for driving a pair of rock drills by compressed air at a considerable distance from the source of power.
8. Describe and discuss the principal machines used for grinding minerals before or during the processes of dressing.

1885.

1. Give an account of the principal European copper mines, indicating the character of the deposits and the quality of the ores produced.
2. Give an account of the Lancashire coal-field, with such details as may be considered important from a mining point of view.
3. What methods are adopted in sinking shafts in very wet ground, such as the magnesian limestone in Durham, &c.?
4. What methods of drawing minerals have been proposed other than winding drums ?
5. Describe, with details, some variety of safety catches, and discuss the conditions necessary to ensure safety with such contrivances.
6. What methods are adopted in working out and securing the ground in very large mineral veins ?
7. Describe some of the principal methods of transferring power from a distant motor at the surface to machinery underground.
8. When a coal seam is on fire undergrouud, how should it be isolated to prevent the fire from spreading to other parts of the workings ?

1884.

1. Give an account of the Oolitic iron ore district of England, comparing it with the analogous district on the continent of Europe.

2. Give an account of the Central English coal-fields, excluding those of North Staffordshire, Derbyshire, and the Welsh border.
3. Give an account of the mines on the great flat lode south of Redruth and Camborne.
4. Describe in detail some form of percussive boring machine, and its application to the sinking of a shaft.
5. What are the explosives known as *nitro compounds*, and how are they used in mining ?
6. What particular kinds of locomotives have been applied for traction underground ?
7. Describe the principle and construction of Carr's disintegrator.
8. What are the most improved arrangements for shipping large cargoes of steam coal ?

1883.

1. Give an account of the Yorkshire and Derbyshire coal-fields, specifying the nature of the seams in the different districts, their relation to the overlying strata, and the special methods of working followed.
2. Describe the mining characters of the Saint Just district in Cornwall
3. Give an account of the principal districts producing zinc ores.
4. Give an account, with sketches, of Davey's direct acting compound pumping engine.
5. Describe, with sketches and dimensions, two of the principal forms of fans used for ventilating collieries.
6. Give an account of the arrangements necessary for the safe and economical working of a large colliery where only safety-lamps are used. Illustrate your answer by the details as to working force, distribution of duty, and supervision in some actual working.
7. What are the arrangements adopted for impounding, distributing, and discharging water in mining districts depending entirely on hydraulic power ?
8. Describe, with some illustrations, the different classes of machines used for breaking, crushing, and grinding minerals before dressing.

1882.

1. Give an account of the methods followed in the discovery, winning, and working of the iron ore mines in the Furness and Whitehaven districts.

2. Give an account of the special mining features of the Barnsley district of the Yorkshire coal-field.
3. Compare the different methods that have been proposed for the transmission of power from a fixed motor to a considerable distance.
4. Describe, with sketches, a coal-cutting machine, operating by rotary cutters.
5. How would you arrange the working force in a large level driven by machine power, where rapidity of advance is a principal consideration?
6. What are *dry* and *wet* air compressors, which kind is preferable, and why?
7. Describe the tail-rope system of underground haulage.
8. Describe the Guibal ventilating fan, with sketches showing the leading dimensions of one actually in use.
9. Give an account of the different kinds of construction adopted in crushing mills for lead ores, in regard to—
   (1) Number, form, and dimensions of rolls.
   (2) Safety contrivances to prevent failure.
   (3) Sizing and screening arrangement.

## SPECIMEN EXAMINATION PAPERS.

### Board of Education, 1893.

### First Stage or Elementary Examination.

1. What is a mineral vein or lode, and how are ores or useful minerals usually found in it?
2. What kinds of metallic ores and other useful minerals are usually found in stream-works or alluvial deposits?
3. What are bituminous, free-burning, and smokeless coals? Give an example of each.
4. When a coal seam is cut off by a fault, what operations are necessary to prove the throw?
5. Describe a method of long wall working on a thin seam with a good roof.
6. Give a sketch of a method of securing a level with timber.
7. Describe the principle of main and tail rope haulage underground.
8. What gases are met with underground, and to what extent are they dangerous in the air of mines?
9. How is circulation of fresh air kept up through the workings of a large mine?
10. Describe the principle of the safety-lamp and the construction of one of the safest forms.
11. How can air be carried to the fore breast or end of a level?
12. Give a sketch of the methods of stoping on a lode and passing the mineral to a level below.

### Second Stage or Advanced Examination.

21. How is the ore-bearing quality of lodes found to be affected by changes in the containing rock or country? Give some examples.
22. How may the minerals in a tin, copper, or lead lode be expected to change in depth when the level of free drainage is passed?
23. In some coal-fields the measures are penetrated by dykes of igneous rocks. What is the effect of such intrusions upon coal seams where they are in contact?
24. How would you prove a coal-field by boring for the purpose of fixing the position of a new sinking?

25. Give a sketch of the method of sinking and walling in ordinary coal shale and sandstone measures when intermediate bearing curbs can be used. What weight of material would be excavated per 100 yards in a pit 16 feet in diameter ?
26. Describe some methods of using iron or steel instead of timber in shafts and levels.
27. Describe a system of working a 4 feet seam of coal of 35 to 50 degrees dip, either by dip or rise working, showing the methods of securing the faces and of removing the coal to the main road, and the course of ventilation.
28. Describe two different kinds of mechanical ventilators, giving their relative efficiency.
29. Describe in detail some form of underground pumping engine.
30. Describe, with figures, the construction of a cage and guides suited for a large colliery.
31. What plans and sections are necessary to represent the workings on a mineral vein ?
32. What is the order of operations followed in cleaning tinstuff containing pyrites and arsenic.

---

HONOURS EXAMINATION.

41. Give an account of the Scotch coal-fields, and compare their geological characters with those of the northern counties of England.
42. What are the principal deposits and the nature of their minerals producing iron ores of Bessemer quality in Europe at the present time ?
43. Describe the Poetsch system of shaft-sinking and the conditions limiting its use.
44. What arrangements are necessary for rapidly driving a large level by machine boring ? Give some figures illustrating a possible example.
45. Describe the Guibal fan as originally constructed, and in some newer, modified, or derived form, giving the reasons for such modifications.
46. Describe Mr. Moore's system of hydraulic transmission of power from surface to pumps underground.
47. Describe a modern system of screening a large output of coal with a minimum of breakage.
48. Give some account of a stamp mill suitable for crushing 100 tons of hard vein stuff in 24 hours.

## Board of Education, 1894.

### First Stage or Elementary Examination.

1. What is a mineral vein, and how does it differ from a bed or seam ?
2. What are the Coal Measures, and how are coal and other minerals distributed in them ?
3. Describe the tools required in boring by hand power to a depth of 200 feet.
4. Sketch and describe some form of drill for boring holes for blasting.
5. Describe the operations of sinking a pit 12 feet in diameter, and lining it with brickwork.
6. What are shafts, stopes, passes, and winzes ? Show the application of these terms in a sketch of a mine on a lode.
7. What methods of guiding skips or cages are used in vertical and inclined shafts respectively ?
8. What is meant by splitting and regulating air-currents ?
9. How can a siphon be used in lifting water underground ?
10. What precautions are necessary in approaching old workings likely to contain water ?
11. What circumstances are to be considered in determining the length of stalls in long wall working ?
12. Arrange the following minerals in order of density, and give the weight of a cubic foot of each :—Galena, quartz, pyrites, blende, and spathic iron ore.

### Second Stage or Advanced Examination.

21. What is anthracite coal, and how is it prepared for use ?
22. Describe the Oolitic iron ore districts of England south of the Humber.
23. What is meant by the natural water level, and how does it affect the minerals in a lode ?
24. How can cast-iron be used for securing shafts and levels ?
25. Give some account of the use of electricity in blasting operations.
26. What are the chief points to be considered in selecting a system (pillar and stall or long wall) in working a coal seam ?
27. Explain the terms rubbing surface, area, perimeter, and section of an air-way, and determine them for a rectangular level 6 by 7 feet, 500 yards long.

28. What methods have been proposed for detecting small quantities of gas in the air of mines ?
29. How would you keep the true alignment and gradient in driving a gallery ?
30. Describe and compare the Guibal and Waddle fans.
31. What contrivances have been used for reducing violent strains on winding ropes ?
32. In the dressing of minerals the vein-stuff may be finely powdered at once, or subjected to gradual crushing and sizing. State the conditions determining the use of either method.

---

HONOURS EXAMINATION.

41. Give an account of the Yorkshire and Derbyshire coal-field, indicating districts where it is likely to extend below newer formations.
42. What are the principal mining districts in Europe producing spathic iron ore ?
43. Describe a method of underground haulage, giving details of the mode of attachment of the tub to the hauling rope.
44. What causes have been assigned for the spontaneous ignition of coal in mines, and how should such fires be dealt with ?
45. Describe some methods for preventing over-winding.
46. Sketch out a plant for winding 800 tons in a 10-hour shift from a depth of 400 yards, giving dimensions of engine, cylinder, drum, pit-head, and pulleys, and state the number and kind of boilers required, the working steam pressure to be 45 lb. per square inch.
47. Describe the method of treating gold quartz by battery amalgamation when there is a notable quantity of sulphide minerals in the vein-stuff.
48. Describe some method of working a coal seam where the excavation is stowed with rock as the coal is removed.

---

BOARD OF EDUCATION, 1895.

FIRST STAGE OR ELEMENTARY EXAMINATION.

1. Describe with figures and dimensions two forms of miners' picks as used either in coal or metalliferous mining.
2. What is the composition of common blasting powder, and what methods have been suggested for increasing its efficiency ?
3. Give a sketch of the construction of a horse-whim or gin, stating within what limits it can be usefully applied.

4. Describe two methods of timbering a level suitable to resist side and top pressure respectively.
5. Give the weight per fathom, ultimate strength, and safe working load of a crucible steel wire rope 4 inches in circumference.
6. Describe the general character and structure of a coal seam, and its associated strata.
7. Describe a simple method of boring for coal, and state how the section is recorded when solid cores are not obtained.
8. How can a level be driven in fiery measures without the use of explosives ?
9. Describe the pillar and stall method of coal working in two modifications.
10. How is a coal mixed with shale prepared for market ?
11. What are stratified and unstratified mineral deposits ? Describe the characters of each kind, giving some examples.
12. What are ores, veinstuff, waste, and deads ? Give some examples of the application of these terms.
13. What are the principal methods of working on lodes, and what conditions are best suited to each one ?
14. How are the pumps of a deep mine usually arranged, when worked by an engine at the surface ?
15. What minerals are commonly found in the veinstuff of a tin lode, and how is the tin ore separated ?

Second Stage or Advanced Examination.

21. Illustrate the construction of—
    (*a*) A cage for a vertical shaft ; or
    (*b*) A skip for an inclined shaft,
    giving details of the method of attachment of the winding rope.
22. Describe the construction of a dam to resist a heavy pressure of water in a level.
23. Describe some method of raising water from a deep mine, without pumps.
24. What gases are likely to be found in the air of coal and metal mines respectively ? State generally the appliances required for ventilating either class of mines.
25. What arrangements are desirable in connection with the winding arrangements of a deep mine to ensure safety when winding at a high speed ?

26. What are faults in coal seams, and how may they be expected to influence the working of mines ?
27. Describe the operation of boring for coal at a great depth by a method giving solid cores of the strata passed through.
28. Describe in detail a method of long wall working suitable for a 4-feet coal with a dip of 1 in 6, showing the best method of securing the face.
29. Describe the Pieler and Clowes methods of testing for gas.
30. Notice some of the principal forms of screens used for sizing coal.
31. What ores are found in the carboniferous limestone formation of England ? Give some examples of particular mines.
32. What are the principal ores of manganese, and under what conditions have they been found in this country ?
33. How can prospecting for lodes be carried out in a country with a heavy drift covering ?
34. Describe a method of working on a large lode where the excavation is too wide to be spanned by single timbers.
35. Describe the round buddle and some of the newer slime dressing machines developed from it.

HONOURS EXAMINATION.

41. Give an account of the South Staffordshire coal-field, noticing such points in geological structure and methods of working as are of special mining interest.
42. What are the principal copper-producing districts of the world ? Describe one of them in detail.
43. Describe in detail the construction and method of erection of a system of tubbing for a pit 16 feet in diameter, starting from a depth of 70 yards below the surface.
44. Describe the Brandt rotary rock-drill, and give examples of results obtained with it.
45. What appliances are required for maintaining and measuring the air circulation in a mine, and what power will be required to move 100,000 cubic feet per minute at $3\frac{1}{2}$ inches water-gauge ?
46. Give a general description of the Cornish pumping engine, and notice some of the newer forms of engines that have been introduced as substitutes.
47. A system of mechanical haulage is required in a level 1,800 yards long to deliver 200 tons of coal in 10 hours to a pit eye 400 yards below the surface. State generally what arrangements you would prefer for this work.

48. What errors in direction are likely to arise in surveys made with the magnetic needle, and how can such errors be controlled and corrected ?
49. What plant will be required for washing 100 tons of small coal per hour by the Lührig or some other approved method ?
50. Give an account of the methods of working and milling the ore of the banket formation of the Transvaal.

---

Board of Education, 1896.

First Stage or Elementary Examination.

1. What tools are required for boring shot-holes (*a*) by jumping and (*b*) by single-handed drilling ?
2. Sketch and describe two methods of securing a large level with masonry.
3. Explain the construction and uses of the capstan and shear legs of a pumping engine shaft.
4. Compare the weights and strengths of a round wire rope $3\frac{1}{2}$ inches circumference and a flat one $2\frac{3}{4}$ inches by $\frac{1}{2}$ inch, both of best plough steel quality.
5. What are the best methods of preserving timber for underground use ?
6. What is anthracite, and where is it principally found ?
7. What natural systems of division are found in coal seams, and how does their position affect the working ?
8. What is long wall working and how is it applied (*a*) in a flat seam and (*b*) in one with a high dip ?
9. Explain the uses of the barometer, thermometer, anemometer, and water-gauge in controlling the ventilation of mines.
10. What special regulations should be observed in mines subject to sudden outbursts of gas ?
11. What is the general rule for determining the direction of the heave when a lode is thrown out by a cross course ?
12. What is the composition of Wolfram, how does it occur, and for what is it used ?
13. What minerals are usually associated with lead ore in lodes (*a*) in granite and (*b*) in limestone country ?
14. How would you arrange a long stroke pump-rod in a shaft when the angle of inclination increased 15 degrees ?
15. Describe the principle of dressing minerals by jigging, and show how it is done (*a*) by hand and (*b*) by mechanical appliances.

SECOND STAGE OR ADVANCED EXAMINATION.

21. Describe and illustrate the construction of the Ingersoll Rock Drill.
22. What are safety explosives, and what precautions are necessary to ensure their acting without a flame ?
23. A pit is 16 feet in diameter and 200 yards deep. What is the weight of rock (shale and sandstone) excavated, and how much land will it cover when tipped as a square pyramid 32 feet high ?
24. Give some figures, with dimensions and weights, of steel bars and arches for use in levels in the place of timbers.
25. What is the Riedler system of construction of pumps and compressors, and what are its advantages ?
26. What properties are most valued in steam, gas, and coking coals respectively ?
27. Describe the Lancashire system of working steeply inclined coal seams.
28. On a seam dipping south 1 in 6 what will be the gradient of a road driven N.E., and would such a road be suitable for horse traction ?
29. What methods have been adopted for systematically keeping down the dust in coal mines ?
30. What is meant by *equivalent orifice*, and how is the term applied in discussing the efficiency of ventilating machines ?
31. When the country of a lode changes from one rock to another, how is the ore-bearing character affected ? Give some examples.
32. Describe a method of working a large lode with complete filling or packing in the stopes.
33. When a lode is dipping at a low angle, how can the contents of a stope be determined from the plan and vertical section ?
34. What are the most important zinc ores, and the principal localities producing them at the present time ?
35. Describe the principal slime dressing machines in which a percussive action is employed.

HONOURS EXAMINATION.

41. Give an account of the Lancashire and Cheshire coal-field, noticing points of technical mining interest.

42. How is tin ore found in the following districts:—
    (*a*) Cornwall, Camborne, and St. Ives districts.
    (*b*) Tasmania.
    (*c*) Perak.
    (*d*) Bolivia.
43. Describe the construction of a self-tipping skip suitable for a 2-ton load in an inclined shaft.
44. Sketch an iron tub for carrying 10 to 12 cwts. of coal, giving dimensions and details of construction, including the arrangements for lubrication.
45. Describe the Poetsch method of shaft sinking, noticing specially the points upon which its success depends.
46. In a working dipping 1 in 10 water accumulates at the rate of 3,000 gallons per day at a point 500 yards from a shaft. How would you deal with the water?
47. Describe in detail the construction of an 18-inch planner-lift of 10-feet stroke, with its intake 200 fathoms deep. How much water would it lift at five strokes per minute, and what power would be required to work it?
48. How would you construct a dam in an abandoned shaft to prevent the influx of water from shallow to deep workings?
49. Sketch out a plant for disposing of the output of a shaft drawing 100 tons of coal per hour, using 10-cwt. tubs and two-decked cages. The coal to be hand-picked and screened, but not washed.
50. What plant would you specify for producing 30 tons of black tin per month from 2 per cent. tin-stuff, supposing calcining to be necessary?

---

## Board of Education, 1897.

---

### First Stage or Elementary Examination.

1. Describe the tools required for boring and blasting in hard ground.
2. How would you sink and secure a small shaft in ground requiring timber?
3. Sketch and describe the method of timbering the junction of a main and a branch road where the roof is weak.
4. Describe the construction and method of working of the plunger pump, as used in a deep mine.
5. What arrangements are required for safety in winding and landing minerals from a deep shaft?

6. What are the different kinds of coal produced in the United Kingdom ? Give their average specific gravities, weights per cubic yard, and other properties.
7. What are the principal kinds of interruptions met with in working coal seams ?
8. Describe briefly the principal methods of working coal practised in the United Kingdom.
9. Give the composition and the properties of the gases met with in working coal.
10. How is the air distributed to the workings of a large mine ?
11. Describe the ore deposits known as lodes, beds, and stock-works, giving examples of each kind.
12. What are the principal ores of copper ? Give examples of the occurrence of the more important kinds.
13. How is a lode worked by overhand stoping ?
14. Describe the construction of a skip for hoisting in an inclined shaft.
15. What appliances are required for dressing very finely divided ore stuff ?

SECOND STAGE OR ADVANCED EXAMINATION.

21. What are rock-boring machines ? Describe one of them, and explain its use in sinking or driving.
22. Explain the method of firing grouped shots either by fuses or electrically.
23. In a shaft 500 yards deep, the cages, each weighing 95 cwt. including 2 tons net load, are drawn by ropes of 65 tons ultimate strength, weighing 16 lb. to the fathom, winding on a drum 16 feet in diameter. What are the moments of the load at starting, arrival, and at the 10th, 15th, and 25th laps of the rope ? Is the safety factor of the rope sufficient ?
24. How many fillings of a water-box 5 feet deep, 3 feet long, and $3\frac{1}{2}$ feet broad will be required per day to keep down a feeder of 1,000 gallons per hour ? What would be the driving speed of a 3-inch pump 18 inches stroke for the same work ?
25. Describe the operations of sinking and walling a large shaft, noticing arrangements for safety when water and bad air are encountered.
26. A coal seam is $6\frac{1}{2}$ feet thick, with a dip of 1 in 7. What tonnage may be expected from an area 50 chains square ? Supposing the dip to be parallel to one of the sides, the surface level, and the seam to be 200 yards deep at

the rise edge, how would you lay out such a field for working ?

27. Describe the arrangements for ventilating a mine by a furnace when the return air is fiery.
28. Describe the Clanny, Marsaut, and Morgan safety-lamps.
29. Compare the main and tail-rope and endless-rope systems of haulage in their principal features.
30. Notice some arrangements for tipping and screening coal with a minimum of breakage.
31. In what mining districts have mineral-bearing conglomerates been found ? Give some examples of mines working on such deposits.
32. A veinstone contains by volume : quartz 60, spathic iron ore 25, blende 10, and galena 5 per cent.

    What are the weights of lead and zinc ore contained per ton of stuff ?
33. Describe the American and Australian methods of securing large stopes where single timbers are not sufficient.
34. What is the cause of acid water in mines, and how are pumps protected when lifting such water ?
35. Describe, with some details, a modern stamping mill as arranged either for pulverising alone or for pulverising and amalgamating.

### Honours Examination.

41. Describe the Yorkshire, Derbyshire, and Nottinghamshire coal-field, noticing points of geological and technical mining interest.
42. Where is nickel principally produced at the present time ? Notice the character of the deposits and methods of working.
43. A lode contains by volume : tinstone 2, mispickel 5, copper pyrites 1, and waste equal to quartz 92 per cent.

    Supposing it to be 3 feet thick, how many square fathoms of ground must be stoped to return 10 tons of black tin, and how much arsenic might be got in addition ?
44. Describe some form of coal-cutting machine, giving details of the method of driving, arrangement of the working staff, and other details incidental to its use.
45. What kind of a fan would you propose to move 120,000 cubic feet of air at a water-gauge of 2½ inches ? Give details as to size, method of driving, and other essential particulars.

46. It is required to raise 300 gallons of water a minute from a mine 400 yards deep. Give a general sketch, with leading dimensions, of the plant you would prefer for the work.
47. Give an account of the explosives used in mining, noticing their relative power, safety, and cost for different uses.
48. Describe the method of working irregular deposits of iron ore practised in Cumberland and Lancashire.
49. Describe some methods of conveying coal from the face to the main roadway used in working coals with a high dip.
50. What plant would you require on a dressing floor to dress 600 tons per month of vein material similar to that of Question No. 43 ?

---

## PRINCIPLES OF MINING, 1898.

### FIRST STAGE OR ELEMENTARY EXAMINATION.

1. What kinds of picks are used underground ? Describe three of the commonest forms.
2. How is a shaft (either round or rectangular) arranged, when it has to serve for travelling, pumping, and hoisting purposes ?
3. Describe two cases of timbering a level, one where the roof and one wall are weak, and the other where support is required on all sides.
4. What is meant by a 10-inch pump of 5-feet stroke ? How much water will such a pump lift per hour, when working at 8 strokes per minute ?
5. What kinds of winding ropes are used in deep mines, and what conditions are best suited to each kind ?
6. What is bituminous coal ? Describe the principal varieties, and their uses.
7. What is meant by the throw of a fault, and how is it determined when working a coal seam ?
8. Describe the long wall method of working in two varieties.
9. Describe the composition and properties of fire-damp, and state how its removal from mines is effected.
10. How is the air carried through the workings of a mine when several detached ends have to be ventilated ?
11. What are mineral veins or lodes, and how are they classified ?
12. What methods are adopted for working mineral veins, and how are they modified for lodes of large size ?

13. What is iron pyrites, and what associated minerals often make it valuable for other metals? Give some examples.
14. What rules should be observed for safety in the event of miss-fires in blasting?
15. How are minerals crushed before dressing, by other contrivances than stamps?

Second Stage or Advanced Examination.

21. Describe some rock-boring machine and the arrangements necessary for its use in driving a large level rapidly.
22. How are cast iron and steel used for supporting excavations underground? Give some examples.
23. What kinds of winding drums are used in drawing from deep mines? State the reasons for the adoption of each kind.
24. What is the principle of the differential or telescopic pump, and how is it applied in deep mines?
25. How would you arrange the bank or collar of a large shaft in a flat country, when head room for screens or other purposes is required?
26. What are the constituents ordinarily determined in coal by analysis? Give their relative importance in determining its value.
27. A band of shale 5 inches thick occurring with a 4-feet coal seam is used for building pack walls on the roads in a long wall working. How thick can these walls be made supposing the roads to be 25 yards apart?
28. How can the safety-lamp be used as a fire-damp detector? Describe some lamps arranged for this use.
29. What arrangements have been proposed and adopted for keeping down dust in coal workings?
30. What mechanical effort is represented by a current of air of 40,000 cubic feet per minute at $1\frac{3}{4}$ inches water-gauge, and at what speed would this pass a roadway 8 feet broad and 10 feet total height with a semi-circular roof?
31. A vein stone contains 4 per cent. of copper as copper pyrites, the waste being quartz. What proportion by bulk does the ore represent, and what is the weight per cubic foot of the vein stuff?
32. Describe the arrangements for filling and landing skips when winding from an inclined shaft.
33. Describe some method of working a mineral vein of large size.
34. Describe the principle of the man engine as applied in deep mines and the circumstances tending to restrict its use.

35. What are jigging machines, and what is their function in the dressing of mixed ore stuff ?

HONOURS EXAMINATION.

41. How are the Carboniferous strata classified in Great Britain ? Give the thickness and other details of the different members with examples of localities where the section is continuous and others where there are gaps in the veins.
42. Notice the principal metalliferous regions in the Carboniferous Limestone regions of England and Wales.
43. Describe the conditions under which tin ore is found in England, noticing some instances in detail.
44. What principles have been adopted in the design of coal-cutting machines ? Describe the construction and use of one form.
45. Describe some methods that have been adopted for breaking down hard rock without explosives.
46. How are deep holes bored for exploring purposes ? Describe the method of carrying out such a work noticing the different accidents liable to occur during its progress.
47. Describe the method of sinking and securing a deep shaft by means of tubbing. What rules have been proposed for determining the thickness of tubbing in proportion to the depth, and how do such rules compare with the dimensions actually adopted ?
48. Sketch out a plan for the arrangements for onsetting and disposal of empty tubs at the bottom of a deep pit where 1,000 tons are wound in 10 hours.
49. Describe the construction and arrangements of a ventilating fan suitable for exhausting 100,000 cubic feet of air per minute at 3 inches water gauge.
50. How do explosives vary as regards (*a*) temperature of ignition, and (*b*) maximum flame temperature, and what methods have been proposed to reduce the latter temperature artificially in safety explosives or cartridges ?
61. Describe the arrangements adopted for cages in deep mines, comparing those of wide and narrow shafts where a heavy load has to be lifted.
62. What arrangements have been used for automatically reducing the speed of winding engines near the end of the lift ? Describe some one in detail.
63. In a pit 1,127 yards deep, with a head frame 65 feet high, the loaded cage with three tons of coal weighs six tons, the rope averages 23·2 lb. per yard, and the radius of

winding varies between 5·3 and 13·8 feet. Compare the moments of the load upon the drum shaft (in foot tons) at starting and arrival respectively.

64. What proof and safety limits are adopted for mining ropes of different kinds? What would be a proper size for a high class steel wire rope to draw a gross load of six tons from a depth of 600 yards?
65. Under what circumstances are adit levels used for draining mines? Give some particulars of the principal adit levels in European mining districts.
66. Describe the Galloway self-filling water tub.
67. What is the Pulsometer, and how is it used as a mining pump?
68. Give an account of the forms of valves used in mining pumps, noticing the conditions best suited for each kind.
69. How should the surface arrangements of a colliery be planned when the small coal requires to be washed before coking?
70. Describe the construction of some of the principal slime-dressing machines, indicating their positions and uses in general ore dressing plants.

---

## PRINCIPLES OF MINING, 1899.

### ELEMENTARY STAGE.

1. What are the principal kinds of materials used in the construction of guides in shafts?
2. What gives rise to natural ventilation, and how is natural ventilation affected by changes of weather?
3. Describe two ways of emptying a water-barrel after it has reached the surface in a vertical shaft.
4. What are the essential parts of a winding engine actuated by steam?
5. Describe the operation of stemming or tamping a shot-hole in which the charge is to be fired by means of a squib.
6. Given two fires burning in open grates—one of bituminous coal, the other of anthracite—what differences can you detect between them?
7. What is an explosion of fire-damp, and how may such an explosion be originated?
8. By what means, consecutively, would you transport mine-waggons from a group of working places 2,000 yards away to the bottom of the shaft in a comparatively level mine?

9. Why does a Davy lamp prevent the communication of flame from its interior to its exterior when placed in an explosive mixture of fire-damp and air ?
10. Show how the ground behind an upthrow or downthrow fault can be explored in the most expeditious and least expensive manner when the position of the seam you are in search of is not known.
11. Show how the exploratory workings in a lode are laid out, commencing from a sloping shaft 200 yards deep and extending to a distance of say 100 yards on each side.
12. Show how the deads are supported and how the ore is removed from say eight adjoining overhand stopes in a lode 3 feet wide.
13. How are the plungers of three successive lifts of pumps attached to the pump rods, and how are the pump rods prevented from bending, above and below the points of attachment, while they are working ?
14. How would you sink a shaft through 6 feet of running sand at the surface ?
15. What is the composition of the following metallic minerals : Hematite, Galena, Argentite ?

ADVANCED STAGE.

21. What aggregate effective horse-power is required to raise 100 gallons per minute from a depth of 1,000 feet, 200 gallons from a depth of 700 feet, and 400 gallons from a depth of 300 feet, leaving friction and leakages out of account ?
22. Given a manometrical depression, or water-gauge of 2 inches, what effective horse-power is required to cause 80,000 cubic feet of air to circulate per minute ?
23. How are the distributing or slide valves of a duplex pumping engine generally actuated ?
24. Describe the general forms and uses of the following tools and appliances employed in boring with solid iron rods :— Chisel or cutting tool ; Freefall apparatus ; Shell-pump or sludger ; Claw or crow's foot.
25. Describe the operation of tubbing a shaft with cast-iron.
26. Given the analyses of a number of samples of coal—Carbon, Hydrogen, Oxygen, and Nitrogen, calculated as percentages independently of Ash, Sulphur, Phosphorous, and Moisture, and the moisture given as a percentage of the whole—how would you be able to distinguish in a general way between Lignite, Long-flaming bituminous coal, Caking coal, Semi-bituminous coal, and Anthracite ?

27. Describe one method of taking out pillars in a seam of medium thickness (3 to 8 feet) lying at a moderate inclination (3° to 10°). Show how the coal is carried away from the face, how the roof is supported, and how the ventilation of the face is effected.
28. Describe the Pillar and Stall method of working as practised in the South Wales coal-field—either single-road stall or double-road stall, but not both.
29. What observations would you make in order to calculate the work done in ventilating a mine? Describe the operations and name the instruments made use of. *N.B.*—This question does not in any way refer to t e efficiency of the ventilator.
30. Describe one means in each case for securing the tubs or trams in a cage, supporting the cage on a level with the surface, and unloading the cage by mechanical means. The description of complicated appliances is to be avoided.
31. Describe arrangements for guiding skips in a sloping shaft, and show how friction is reduced.
32. Name certain localities in which large deposits of iron pyrites, native copper, and diamond-bearing rock occur.
33. How many pounds of lead are contained in a ton of pure galena, and how many pounds of iron in a ton of pure hæmatite?
34. What method of working would you adopt in the case of a practically inexhaustible mass or a thick bed of mineral of small intrinsic value, such as limestone, slate, basalt, sandstone, granite, and so on, supposing quarrying or open-cast working to be inadmissible?
35. Describe a pair of crushing rolls, and show what arrangement is made to prevent breakage of the machinery in the event of a piece of unbreakable substance coming between the rolls.

HONOURS.

41. Name the principal divisions of the Carboniferous Formation in any one of the well-known coal-fields in England, Wales, or Scotland, commencing at the base of the Formation and proceeding upwards. State, further, in as few words as possible, what is the distinguishing feature of each division, the nature of the rocks of which it is principally composed, and the average number of seams of coal, if any, contained in it.

42. Describe the characteristic features of any well-known deposit of tin ore, lead ore, or iron ore in Great Britain. Show how the ore occurs in the ground, describe the character and composition of the vein-stone or matrix, if any, and state the nature and composition of the rocks in which the ore is enclosed, or of which it forms a part in the case of an impregnation or replacement.

43. Describe a percussive rock-drill actuated by compressed air. Give details of the following parts : (*a*) the means whereby the compressed air is admitted alternately to the opposite ends of the cylinder ; (*b*) the appliance which causes the tool to rotate ; (*c*) the mechanism which advances the boring engine and tool as the hole is deepened.

44. Describe the essential parts of a diamond rock-boring plant for boring large exploratory bore-holes vertically downwards, and proceed in the following order :—(*a*) the crown ; (*b*) the boring rod ; (*c*) the appliance used for introducing a continuous stream of water ; (*d*) the appliances used for partially balancing the weight of the rod ; and (*e*) the mechanism which causes the rod to revolve. Omit all other details.

45. Describe in a general way (without entering into minute details) Poetsch's method of sinking by freezing the ground :—(*a*) the construction of the tubes in which the cooling liquid circulates ; (*b*) the means of distributing that liquid amongst the circulating tubes and collecting it after it has traversed them ; (*c*) the means by which cold is produced ; (*d*) the means by which the cooling liquid is caused to circulate ; (*e*) the chemical composition of the cooling liquid, and show how and when the shaft is lined in the water-bearing ground.

46. Describe the most approved method of working a thick seam or lode (say 50 feet) lying at a high inclination (say 60°) in which a complete stowing consisting of materials brought from the surface if necessary is employed.

47. Express the chemical composition of the following gases by means of the usual symbols :—

Carbon dioxide (carbonic acid gas).
Carbon monoxide (carbonic oxide).
Marsh gas (fire-damp).
Sulphuretted Hydrogen.

Under what circumstances may one or more of these gases occur in a mine ?

How can the presence of each be detected in a summary manner? What effect is produced if any one of them is allowed to accumulate in a mine in which naked lights are used?

48. What is understood by the expression "Murgue's equivalent orifice," and what practical application can be made of M. Murgue's formula in connection with the problems of ventilation?

49. Give a detailed description of the appliances required in a balance pit with only one cage for letting down minerals from a higher to a lower level, and show how they are worked.

61. Given the weight of 16,000 yards of steel wire rope as equal to the breaking strain of the rope; $s = \frac{1}{10}$th of the breaking strain as the safe working load; $D = 400$ yards, the depth of a shaft in which the rope is to be employed in winding; $Q = 3$ tons, the useful load of mineral; $q =$ 4 tons, the dead weight of the cage, empty waggons, chains, and safety hook; $x$ the weight per yard in pounds of the rope required. Construct the formula for finding the value of $x$, and calculate its value from the numerical data.

62. Describe in detail Kœpe's method of balancing a winding rope.

63. Describe the essential parts of Moore's hydraulic pump, and show how it is worked.

64. Describe the following pieces of mechanism, and show how they may be combined together to form a connected train; a revolving side-tipping apparatus, a screen with moving bars, a picking band, and a loading shoot. Minute details of construction are to be carefully avoided.

65. Describe in detail the various parts of a continuously working washing box or jigger for nut-coal over $\frac{1}{2}$ inch in diameter. Show one method of withdrawing the rubbish from under the water in a continuous manner without interrupting the operations in any way.

66. Describe a continuously working washing box or jigger of the most approved kind for washing small coal under $\frac{3}{16}$th inch in diameter. Show how the mixture of coal and rubbish is introduced into the box, and how the clean coal and rubbish are removed from it separately without interfering with the continuity of the operations.

67. Describe the various processes through which quartz, containing finely disseminated gold, passes, after it has been delivered from the mines to the dressing works; follow it through each stage until the gold is finally recovered and the barren slime rejected. *N.B.*—The quartz is supposed to contain nothing but gold. The machines are to be described only in a summary manner, and not in detail in this place.

68. Describe the various processes involved in the recovery of nut-coal of a particular size, say 1 inch to $1\frac{3}{8}$ inch in diameter, first from the larger and smaller sizes of coal with which it is mixed when it comes out of the mine, and, secondly, from the rubbish by washing. Follow the nut-coal and the rubbish first when mixed, and, secondly, when separated, until the one is delivered into a truck or a bunker, and the other is deposited on a rubbish heap, naming, but not describing, each machine in succession. Describe the means by which they are transported from point to point, and finally state what becomes of the water.

69. Describe a Frue vanner, and give the reason why the particles of ore separate themselves from the refuse slimes.

70. How would you construct a dam in a heading 6 feet square to resist a great pressure of water?

71. How is the magnetic meridian of a mine determined in the first place and corrected afterwards?

---

PRINCIPLES OF MINING, 1900.

ELEMENTARY STAGE.

1. Describe the various tools employed in boring and tamping a shot-hole by hand, in which a squib is to be used as the means of igniting the charge. State which of the tools must, according to law, be made of some other substance than iron or steel, and why this precaution is adopted.

2. How would you support a timber or brick lining in sinking a shaft in loose ground from the surface downwards?

3. Show how the four pieces of timber which constitute a complete frame for supporting the sides, roof, and floor of a gallery are put together, and how they are shaped at their points of contact with each other.

4. Given a single drum actuated by an engine for drawing mineral up an incline with a rope: How would you arrange the roadways (railways) for the waggons at the top and bottom and on the incline itself?
5. In approaching old workings known to contain water, what precautions are insisted upon by the Mines' Regulation Acts in order to avoid an unexpected irruption of water?
6. What constitutes the essential difference in composition between bituminous, caking, and anthracite coals?
7. Describe the method of preparing a face of coal in a narrow heading, stall, bord, or room, for blasting, so that as much large coal may be obtained, and as little explosive used, as possible.
8. Describe an ordinary bonneted Clanny safety-lamp, and show where the fresh air enters it and where the products of combustion leave it.
9. Show how the stall roadways in a long wall working are prevented from exceeding a certain pre-determined length, that is to say, how they are cut off when they attain that length.
10. Describe the general construction of a common bar screen, and state approximately the width, length, and inclination of a screen of this kind suitable for mine waggons carrying about 15 cwt. of coal.
11. Given the supposed continuation of a lode whose outcrop is covered or entirely hidden under alluvium 10 or 15 feet thick: How would you proceed in order to ascertain its existence or otherwise, and its thickness, if present, in the most certain and satisfactory manner?
12. In what respects do Hematite, Limonite, and Magnetite differ from each other? Name the chemical constituents of each.
13. Describe the system of underhand stoping in a vein of moderate width (say 3 or 4 feet), and state what are its advantages, if any, in comparison with overhand stoping.
14. What are the processes which deteriorate the air in a mine in which no gases of any kind exude from the strata? How do these processes affect the deterioration of the air, and what is the first symptom of that deterioration?
15. Upon what principle does the success of the operation of jigging depend? Describe the result of jigging a mixture of galena and limestone in pieces of nearly equal size.

ADVANCED STAGE.

21. In the American system of boring with the rope describe the various pieces which constitute the string of boring tools attached to the end of the rope (commencing with the cutting tool and proceeding upwards), and state what is the function of each piece. Show how each piece is attached to the one above it, how the highest piece is attached to the rope, how the rope is attached to the boring beam at the surface, and how the boring beam is supported and worked. No further description of the arrangements at the surface is required.

22. In what geological formation are salt and gypsum found in greatest abundance in this country? Describe two methods of extracting salt from the ground, and state when one is to be preferred to the other.

23. What rule is observed in searching for the continuation of a bed or lode beyond an upthrow or downthrow fault? Under what circumstances would you be justified in disregarding that rule?

24. Let $h$ equal the head or water-gauge expressed in inches of water (convertible into pounds pressure per square foot); $c$ the co-efficient of friction per square foot of area of rubbing surface per thousand cubic feet of air per minute; $l$, $p$, and $a$, the length, perimeter, and area respectively of an air-way of uniform section, and $v$ the velocity of the air; construct a formula by means of which the value of $h$ can be found.

25. Describe the method of sinking by means of compressed air. State why this method cannot be employed in sinking to an unlimited depth, and name a limit beyond which it cannot be safely employed.

26. Give a complete description of a cage with two decks suitable for a load of four mine waggons, two in each deck, standing end to end. Show by sketches the construction of the cage, and how it is attached to the winding rope. Show by two sketches how such a cage may be attached to rope guides and to rail guides, and describe the best means known to you for keeping the waggons in position while the cage is passing up and down the shaft.

27. Describe in detail a mechanical wedge suitable for breaking down coal, and show how it is applied.

28. Describe the Lancashire or retrograde system of long wall working, and state what are its advantages and disadvantages compared to long wall working outwards.

29. Describe the various tools employed in drawing out timber, and show by means of sketches how they are applied.
30. Show by means of a plan and two sections how the roof and the face of the coal can best be supported by systematic timbering in a long wall face, say 30 yards wide from centre to centre of two adjacent roads, assuming that the roof requires to be supported, and the coal to be holed.
31. Show by a drawing the positions of a series of mills or passes relatively to a range of, say 10, stopes which they are intended to serve, and give details as to how the mills or passes are timbered, and how they terminate at the top and bottom.
32. Make a sketch of the workings of a metalliferous mine with three levels connected by winzes, and with a range of overhand stopes in each level occupying about one-fourth of its length, but no one range immediately above another. Show how you would ventilate the stopes and levels, using arrows to indicate the direction of the air-currents, and specify the positions of air-doors and stoppings.
33. Describe minutely all the appliances, other than those for excavating, required in sinking and ventilating a winze 100 feet deep.
34. Draw the cross-section and elevation of a battery of five stamps showing how the ore is fed automatically into the battery-box, how the stamps are raised, how the ore is supported when the stamps fall upon it, how and where the pulverised ore escapes, and how it is carried away; and write a short description to explain the drawings.
35. What are the principal constituent minerals of diorite, basalt, and gabbro? Under what form do these rocks occur in nature?

HONOURS.

41. What is meant by the terms contact deposit, and stock-works? Describe one example of each kind of deposit, and illustrate your description by means of sketches.
42. Describe the various phenomena that present themselves successively in following a lode, consisting partly of sulphides, from its outcrop downwards, to a point in the ground at which the circulation of water and air ceases.
43. What is the composition of:—
    (*a*) Dynamite?
    (*b*) Blasting powder?

    What is the essential difference between their modes of ignition?

44. How is an electrical detonator connected to the charge in a shot-hole on the one hand, and to the wires leading to an electrical machine on the other? How are the wires in the shot-hole protected from injury while the hole is being tamped? Draw a section of a detonator, either high or low-tension, and state which it is.

45. It is desired to *rise* a shaft from a lower to a higher working. Describe the whole of the arrangements for ventilating the shaft, travelling in it, supporting the workmen at the face, and disposing of the *debris*. Show, by means of a sketch, the various compartments into which the shaft is divided, as well as all other necessary details.

46. How would you proceed to win and work a seam or lode, four feet thick, with strong walls, producing practically no deads or rubbish, and dipping at an angle of 70°? Give the dimensions of a shaft suitable to this purpose, the number and dimensions of its compartments, the dimensions of the levels, and the distances between them. The method of working is to be such, that the whole, or nearly the whole, of the mineral is removed in one operation, and the empty space is to be filled with stowing brought from the surface. Explain how and where the stowing is introduced into the workings.

47. Describe two methods of closing the top of an upcast shaft, through which air is being drawn by a ventilator at the surface, so as not to interfere to an appreciable extent, either with the ventilation or with the operation of winding. Show the principal details of the arrangement in each case by means of drawings.

48. Describe and make sketches of a waterfall jet machine and a Kĕrtings aspirator, and show how each is employed in practice.

49. Show by means of drawings the construction of the following safety-lamps:—

(*a*) Gray;

(*b*) Mueseler (unbonneted).

Describe the circulation of air in each, and show what prevents the communication of flame from the interior to the exterior of each when it is placed in an explosive mixture of fire-damp and air.

61. Describe in a general way the principal geological features of a gold or platinum placer, and show:—

1. The method of working such a placer other than by dredging or by the hydraulic process.

2. The construction and method of working a sluice, giving the details of the contrivances by means of which the gold or platinum is arrested and recovered.

62. Give a complete description of the endless-chain system of haulage, stating how the chain is attached to the mine waggons when necessary, how the chain and the waggons are taken round curves, and how the waggons are brought under and released from the chain. Describe the arrangement for keeping the chain tight, and the construction of, and method of imparting motion to, the driving pulley.

63. Describe the Cornish pumping engine. Show where, by what means, and at what period of the stroke, steam is admitted to the cylinder, and follow the steam through a complete stroke of the engine, until it is finally condensed. Describe how the piston and pump rods are attached to the beam and state what other rods are also attached to it, and what are their uses. Show how the pumps are attached to the pump-rod. Minute descriptions of the tappet-rod, levers, and cataract are not required; but it must be stated when, and in what manner, each of these pieces of mechanism affects the working of the engine.

64. What is the diameter of the plunger of a pump, with a useful effect of 85 per cent., working at the rate of 40 strokes per minute, with a stroke of 2 feet, and delivering 23·7 cubic feet of water per minute?

65. Give a short description of any coal or metal mine known to you, including: the sizes, depths, and divisions, if any, of the shafts; the character of the winding, travelling, and pumping appliances; the average thickness and leading features of the seam or lode; the methods of working, transporting, and dressing the mineral; the quantity of mineral and rubbish or deads put out daily; and the number of men employed underground and on the surface separately.

66. Describe the construction, and mode of working, of a Carr's disintegrator, and show how motion is imparted to it; how the coal or ore is fed into it, and where the pulverised material leaves it.

67. Describe a revolving picking table suitable for picking the refuse from amongst coal or other mineral by hand. Show how its motion of rotation is effected; where the mineral is delivered on to it; and where and how the cleaned mineral is swept off it automatically.

68. In driving a straight adit level, show how the gradient and direction are preserved, how the ventilation is provided for, and the water kept off the travelling road. Draw two cross-sections and one longitudinal section, giving dimensions in the cross-sections, and show a timber lining in one cross-section, and a brick lining in the other. Name a suitable gradient for carrying off the water.

69. Describe the construction and mode of action of a centrifugal ventilator with vanes revolving within a fixed spiral casing provided with an evasé chimney. Show where the air enters and leaves the casing, and where the region of lowest pressure in the whole ventilating circuit is to be found. State also what relationship exists between the velocity of the tips of the vanes, the manometrical depression, or water-gauge, and the output of air.

70. Draw two elevations and a plan of a headgear with two legs, situate in the same vertical plane, supporting two pulleys, and show in detail how the pulleys are supported. Show also the correct position of the back stays in relation to the drum shaft on the one hand, and to the ropes hanging in the pit on the other, regarded from a strictly mechanical point of view, and state your reasons for selecting that position.

---

## PRINCIPLES OF MINING, 1901.

### ELEMENTARY STAGE.

1. Describe the process of boring a hole to a depth of 60 feet by hand labour in search of a mineral deposit.
2. Draw and describe several forms of mining picks and mining shovels.
3. Draw a good form of wheel for a mine-waggon (*tub, hutch,* or *tram*); state what it is made of, and show how it is attached to the waggon and how the axle is lubricated.
4. Describe the safety-fuse commonly employed, and state how it is used.
5. What kinds of timber are employed in this country for supporting purposes in mines, and how should the timber be stored at the surface ?
6. Make a sketch showing a section of a good safety-lamp. Explain its construction and use.
7. Draw an air-door. Why are air-doors used ?

8. Describe the manner in which water is usually raised in a shaft in course of sinking, and discharged at the surface.
9. Describe the working face at a colliery with which you are acquainted, showing the manner of "getting" the coal and supporting the roof.
10. Describe some of the irregularities occurring in coal seams.
11. Describe the miner's dipping needle and its uses.
12. What is blasting gelatine, and how is it fired?
13. Describe the manner of putting in a "stull."
14. The vertical section shows an adit AB, which is being driven by hand-labour into a hill-side. How would you ventilate the "end" B? (*Sketch not reproduced.*)
15. What are the processes known respectively as "panning" and "vanning," and how are they performed?

### Advanced Stage.

21. How would you endeavour to extract a set of boring-rods after a breakage of one of the rods 300 feet below the surface?
22. Show by drawings how you would support the sides of a circular shaft in dry ground by a lining in which the chief feature is the use of iron or steel rings.
23. Describe various kinds of wire ropes employed in winding and haulage. State in particular the advantages and disadvantages of employing "shaped" wires in the manufacture of wire rope.
24. Explain the construction of some electric fuses and their advantages as compared with ordinary safety fuse.
25. Describe an air compressor for use at mines.
26. Describe an appliance in use (*a*) for preventing overwinding, (*b*) and another for remedying the effects of an overwind.
27. What is oil-shale? Name the geological horizons at which it is known to occur in the British Isles. What useful substances are obtained from it?
28. Give some rules for ensuring safety in blasting or "shot-firing," as far as possible.
29. Describe good forms of safety-lamps as adapted (*a*) for the miner, (*b*) for the fireman, (*c*) for the mine-surveyor.
30. Describe the method of lining a shaft with brickwork, and the chief appliances used.
31. With what minerals is tin ore usually associated? Give a brief outline of a method of dressing tin ore obtained from mines.

32. Draw a set of hand tools for boring holes for blasting and for charging them. Explain how the drills are sharpened.

33. A lode, 4 feet wide, consists of calc-spar with a rib of zinc-blende averaging 15 inches in width. What weight of "stuff" will the lode turn out per fathom, and what weight of zinc-blende, supposing none to be lost in dressing ?

34. Describe the two kinds of man-engines, and state their advantages and disadvantages compared with other appliances for the descent and ascent of mines. Explain why the man engine is gradually going out of use.

35. What method would you adopt for working a wide vein in soft ground ?

HONOURS.

41. Describe the principal deposits of iron ore which are being worked in the British Isles.

42. How would you proceed to search or "prospect" for minerals in a new country ? What indications would you specially look for ?

43. What is Hepplewhite's system of preparing timber for supporting purposes in mines ? What are its merits, and in what collieries can it be used to the greatest advantage ?

44. What are the principal gases which pollute the air of mines ? How can their presence be detected, and how can the amount of the more important be determined quantitatively both immediately underground and also in samples brought to the surface ?

45. What are the most important coal-cutting machines ? Classify them according to the nature of the cutting appliances. Describe two of the machines which are in regular use.

46. What is meant by systematic timbering in working places at collieries ? What advantages are claimed for it ? Describe various ways of carrying it out.

47. Describe, with sketches, the methods of "spiling," "spilling," or "forepoling" through loose ground.

48. Describe a mining anemometer and a water-gauge. Draw them, and state the manner in which they are used. Describe any instrument for measuring, and at the same time recording the volume of air passing through a mine.

49. Describe the nature and composition of some of the explosives placed upon the "Permitted List." What is the test which has to be passed before an explosive is placed upon this list?

61. Describe, with sketches, the plant required for rapid winding from a deep inclined shaft where a large output is necessary.

62. Describe the Wetherill magnetic separator, and mention some of the instances in which it is employed.

63. Explain how haulage is conducted by electric and compressed air locomotives, and compare these two methods of traction for use below ground.

64. What is meant by co-operative drainage? Explain with examples how it is carried out in practice.

65. Draw and explain two good forms of attachment or "capping" for a wire rope. How should wire ropes be tested before and during use? Give some rules for ensuring safety in winding.

66. Explain and illustrate by sketches some methods of loading coal into ships with the object of economising time and labour, and as far as possible preventing breakage of the lumps.

67. Describe, with sketches of the machines and other appliances, the general succession of operations in coal dressing.

68. Describe two forms of electric pumps, one worked directly from the motor and the other with the intervention of gearing. Give details as to speed of driving and quantity of water raised.

69. What considerations should influence (*a*) the choice of the position of a winding shaft of a colliery, and (*b*) the dimensions of the shaft?

---

### Principles of Mining, 1902.

#### Elementary Stage.

1. What kinds of bedded rocks make up the Coal Measures? State what you know regarding their nature, and which of them will generally make a good roof or floor.

2. What is anthracite, and what are its properties? How does it occur, and where are the principal workings for this mineral in the United Kingdom?

3. A cross-measure drift, cross-cut, or drivage at right angles to the strike, is being made by hand through beds of

hard sandstone, as shown by the vertical section, Fig. 1. (*Figure not reproduced*). How would you arrange the shot-holes in the "face" or "end" in order to continue the drivage? State the order in which they should be bored and fired.

4. What are multiple wedges? For what purposes have they been invented? Explain by a sketch how they are used.
5. Describe the method of timbering by cockers (cocker-megs, cocker-sprags, or knee joints), and give reasons for employing this special method of support.
6. Give a sketch of the pit bottom arrangement of some shaft with which you are acquainted.
7. Sketch a steel sleeper, and show how the rail is made fast to it. How do steel sleepers compare in point of economy with wooden sleepers?
8. What are the causes of the deterioration of wire ropes used for winding?
9. Why are counterbalances and catches usually required for pump-rods in shafts? Explain how the counterbalances and catches are constructed and employed.
10. What are the disadvantages of natural ventilation? Give the reasons why it is insufficient in many cases.
11. Describe the manner in which workable deposits of common salt occur in the Earth's crust.
12. In what manner does the form of the ground sometimes afford an indication of a mineral deposit? Give instances.
13. A cross-measure drift, cross-cut, or drivage at right angles to the strike, is being made by hand through beds of hard sandstone, as shown by the vertical section, Figure 1. (*Figure not reproduced.*) How would you arrange the shot-holes in the "face" or "end" in order to continue the drivage? State the order in which they should be bored and fired.
14. What are multiple wedges? For what purposes have they been invented? Explain by a sketch how they are used.
15. What is dry-rot, and how may it be prevented?
16. Why are the working places of many open quarries arranged in steps or terraces?
17. Sketch a steel sleeper, and show how the rail is made fast to it. How do steel sleepers compare in point of economy with wooden sleepers?
18. What are the causes of deterioration of wire ropes used for winding?

19. Why are counterbalances and catches usually required for pump-rods in shafts? Explain how the counterbalances and catches are constructed and employed.
20. What are the disadvantages of natural ventilation? Give the reasons why it is insufficient in many cases.

---

Principles of Mining, 1903.

Advanced Stage.

21. Describe any deposit of stratified ironstone, shale, or fire-clay, with which you are acquainted, giving details concerning its chemical composition, the rocks in which it is found, and its geological age.
22. Explain how geological maps and fossils may be of service to the prospector, in searching for coal, stratified ironstone, shale, or fire-clay.
23. How should low-tension electric fuses be tested before use? (Sketch required.)
24. Describe any two of the following explosives, viz., ammonite, blasting gelatine, dynamite, and roburite, stating the composition of each, its advantages and disadvantages, and the manner of firing it.
25. A round shaft, *A*, *B*, *C*, *D*, 15 feet in diameter, is being sunk vertically through beds of shale and sandstone lying horizontally, as shown in Figure 5. (*Figure not reproduced.*) How would you bore shot-holes for further sinking, and how would you fire them? Make a plan and a section to illustrate your answer.
26. Show by a sketch drawn to scale how coal is usually "holed" or undercut by hand, and how the supporting timber is usually put in. Describe how and why coal is sometimes "got" without "holing."
27. What is the best gradient for a main underground road ("level") on which horses or ponies are used for hauling loaded mine waggons (*tubs*, *hutches*, *corves*) out and empty waggons in, and by the side of which water has to run out? What reasons govern the choice of the gradient?
28. Draw a sinking bucket (*bowk* or *hoppet*). Explain how it is emptied without danger to the men in the shaft.
29. Write out as nearly as you can the Special Rules concerning timbering which have been established at any colliery with which you are acquainted.

30. Draw separately the various parts of a Marsaut safety-lamp which has been taken to pieces for the purpose of cleaning it.
31. Describe any deposit of copper ore, iron ore, lead ore, slate, tin ore, or zinc ore with which you are acquainted.
32. Explain how such appearances as differences in the vegetation, ordinary springs, mineral springs, and gaseous emanations may be indications of mineral deposits. Give examples.
33. How should low-tension fuses be tested before use? (Sketch required.)
34. Describe any two of the following explosives, viz., ammonite, blasting gelatine, dynamite, and roburite, stating the composition of each, its advantages and disadvantages, and the manner of firing it.
35. A round shaft, *A*, *B*, *C*, *D*, 15 feet in diameter, is being sunk vertically through beds of shale and sandstone lying horizontally, as shown in Figure 6. (*Figure not reproduced.*) How would you bore shot-holes for further sinking, and how would you fire them? Make a plan and a section to illustrate your answer.
36. Describe the method of timbering a large shaft in loose ground. (Sketches required.)
37. What is the best gradient for a main underground road ("level") on which horses or ponies are employed for hauling loaded mine waggons (*tubs*, *hutches*, *corves*) out and empty ones in, and by the side of which water has to run out? What reasons govern the choice of the gradient?
38. To what kind of mineral workings do the following Acts of Parliament apply, viz., the Coal Mines Regulation Acts, the Metalliferous Mines Regulation Acts, and the Quarries Act? Explain fully, and give examples from your own knowledge.
39. Describe any kind of crushing rolls with which you are acquainted.
40. What is the composition of ordinary atmospheric air, and to what extent does the air in mines sometimes differ in composition from ordinary air? Explain the reasons for the difference sometimes met with.

HONOURS.

41. Describe *either* (*a*) some deposits of true coal which occur in rocks other than the Coal Measures, *or* (*b*) the modes of occurrence of rock salt, natural gas, and petroleum.

42. Gold having been found in alluvium and in the outcrops of veins, how would you proceed to determine the extent and value of the deposits? Explain fully, with sketches.
43. Explain fully a method of boring holes 500 feet deep by iron or wooden rods, describing the plant and tools employed, both while carrying on operations necessary for boring and for remedying the effects of common accidents. (Sketches required.)
44. Give a full account of Stanley's "heading machine" or of any other tunnelling machine. (Sketch required.)
45. Point out briefly the different modes of supporting loose and difficult ground when driving or sinking. Indicate their different advantages and disadvantages. (Sketches required.)
46. Describe a large and important self-acting inclined plane dipping at an angle of 45°. (Sketches required.)
47. Draw and describe four different kinds of wire-rope used for winding, and four different kinds of attachments or "cappings." Which kind of rope has proved the most durable in actual practice? How often should the "cappings" be removed, and why? Discuss the proportion which should exist between the working load of a wire-rope and its breaking strain.
48. Discuss fully the method of working a bed of coal, ironstone, or other mineral by the pillar and stall system. (Sketches required.)
49. What is the "square set" system of timbering, and how is it applied? Explain how the timber is prepared. What are the advantages and disadvantages of this system of timbering? (Sketches required.)
50. Describe the Kœpe system of winding. (Sketches required.)
51. Explain fully how force-pumps are worked underground by reciprocating rods actuated by engines at the surface, giving dimensions of the rods, &c., under different circumstances. Compare this system of draining mines with other systems. (Sketches required.)
52. Describe with full details the Whiting system of hoisting or winding from deep mines. (Sketches required.)
53. Explain the different ways in which dust is dangerous in mines. What precautions are taken or should be taken to lessen or prevent the dangers caused by dust? (Sketches required.)
54. Describe with full details the Poetsch or freezing process for sinking through watery strata. (Sketches required.)

55. What are the various dangers in the use of electricity in mines, and how may they be guarded against? (Sketches required.)
56. Describe either some coal-washing plant with which you are acquainted, or some dressing plant for treating the ores of copper, lead, tin, or zinc, with which you are acquainted, in each case pointing out the character of the minerals treated, the purity of the products obtained, and the losses of valuable substances. (Sketches required.)
57. Describe very fully the various appliances which are in actual use at mines for determining the percentage of fire-damp in air. (Sketches required.)
58. What are the requirements of the Coal Mines Regulation Acts and of the Metalliferous Mines Regulation Act concerning plans of mines and concerning shafts? Explain fully the reasons for the statutory regulations.
59. Describe two distinct kinds of electric percussive drills. Explain fully how the current is conveyed underground. State how the electric drill compares with the compressed air drill as regards efficiency. (Sketches required.)
60. Describe the "wire-saw" and the manner in which it has been applied in quarrying stone or slate both in open and underground excavations. (Sketches required.)

---

PRINCIPLES OF MINING, 1905.

ELEMENTARY STAGE.

*Branch A.*

1. What is oil-shale, and what are its special properties and uses? How is it found?
2. Describe two forms of miners' picks, giving sketches and dimensions.
3. Describe a method of timbering a main road in a colliery. (Sketch required).
4. Describe the operation of getting coal on a long wall face. (Sketches required.)
5. Describe the manner in which a door should be set up in a wagon-road in order to close automatically. (Sketch required.)
6. How are the lifts arranged in a deep-mine pumping engine? (Sketch required.)
7. What is the quantity of air per minute passing through an air-way 8 feet 6 inches wide and 6 feet 6 inches high when the velocity of the current is 12 feet per second?

8. What is fire-damp? What chemical changes are brought about by its explosion?
9. What precautions are necessary in approaching old workings likely to contain water?
10. Describe the principle of the safety-lamp, and the construction of one of the best forms. (Sketch required.)

*Branch B.*

11. State what you know concerning the nature and extent of any workable deposit of tin ore, *or* of slate. (Sketch required.)
12. Describe two forms of miners' picks, giving sketches and dimensions.
13. Describe a method of timbering a level in a mine. (Sketch required.)
14. Describe the operation of getting mineral in a working place at some mine or quarry with which you are acquainted.
15. Describe the manner in which a skip in an inclined shaft should be constructed so as to be self-discharging. (Sketch required.)
16. How are the lifts arranged in a deep-mine pumping engine? (Sketch required.)
17. What is the quantity of air per minute passing through an air-way 8 feet 6 inches wide and 6 feet 6 inches high when the velocity of the current is 12 feet per second?
18. What foul gases occur most commonly in metal mines? How would you detect them?
19. What precautions are necessary in approaching old workings likely to contain water?
20. What means of illumination are employed in underground workings? (Sketches required.)

---

Principles of Mining, 1906.

Elementary Stage.

*Branch A.*

1. What is anthracite, and what are its special properties and uses? Where is it mined?
2. Describe the operation of shot-firing with an explosive on the "permitted list." (Sketch required.)
3. What precautions should be taken in withdrawing timber when the roof is bad? (Sketch required.)
4. Describe the pit-bottom arrangements at some colliery with which you are acquainted. (Sketch required.)

5. Describe the best form of wheels for mine wagons, and the most economical method of greasing their bearings. (Sketches required.)
6. In what manner should a cage be attached to the winding rope ? (Sketch required.)
7. Explain the action of the plunger pump used in mines, and state its advantages over a bucket lift. (Sketch required.)
8. Supposing 40,000 cubic feet of air per minute to be passing through an air-way 8 feet 9 inches wide and 7 feet 3 inches high, what is the velocity of the air per second ?
9. Explain the action of any centrifugal fan with which you are acquainted. (Sketch required.)
10. Describe the safety-lamp with which you are most familiar, and state the method of locking adopted. (Sketch required.)

*Branch B.*

11. Give particulars of the nature and extent of any workable mineral deposit (other than coal) with which you are acquainted.
12. Describe the operation of shot-firing with an explosive of the nitro-glycerine class. (Sketches required.)
13. What precautions should be taken in withdrawing timber when the roof is bad ? (Sketch required.)
14. Describe the operation of filling mineral into a skip in an inclined shaft. (Sketch required.)
15. Describe the best form of wheels for mine wagons, and the most economical method of greasing their bearings. (Sketches required.)
16. In what manner should a cage or a skip be attached to the winding rope ? (Sketch required.)
17. Explain the action of the plunger pump used in mines and state its advantages over a bucket lift. (Sketch required.)
18. Supposing 40,000 cubic feet of air per minute to be passing through a level 8 feet 9 inches wide and 7 feet 3 inches high, what is the velocity of the air per second ?
19. Why are the working places of quarries usually arranged in steps or terraces ? (Sketch required.)
20. Give detailed description of the various kinds of candles used by miners, stating their relative advantages and disadvantages.

STAGE 2.

*Branch A.*

21. Describe fully any deposit of fire-clay, oil shale, or stratified ironstone with which you are acquainted.

22. Give particulars of the results obtained in the search for coal under the secondary rocks of this country.
23. Describe one of the coal-cutting machines of the disc type. (Sketch required.)
24. Describe the method of "spilling" or "forepoling" for driving through loose, watery, or running ground. (Sketch required.)
25. What is meant by the term "self-acting incline"? State the conditions under which such "inclines" may be used, and the precautions to be adopted for the safety of persons employed in connection with them. (Sketch required.)
26. Describe an ærial ropeway. In what circumstances is this method of haulage most suitable? (Sketch required.)
27. What are the chief causes of the deterioration of winding ropes, and what remedies are used?
28. What horse-power is required to lift 18,000 gallons of water per hour from a dip working 1,500 yards distant from the shaft, the average gradient of the road being 1 in 5? The friction in the pipes is to be neglected.
29. What effect has "splitting" the air on the ventilation of mines, and what benefits are to be gained by increasing the size of air-ways?
30. Describe the construction of a travelling belt for coal picking and conveying. Explain how the belt is driven, and what arrangements are made for taking up any slack on the belt. (Sketch required.)

*Branch B.*

31. Describe any one important deposit ore, of *or* of slate, *or* of rock salt with which you are acquainted.
32. What are "gossans?" How are they formed, and what indications are afforded by them?
33. Describe an arrangement for automatically rotating the drill in a compressed-air percussive rock-drill. (Sketch required.)
34. Describe the method of "spilling" or "forepoling" for driving through loose, watery, or running ground. (Sketch required.)
35. What is meant by the term "self-acting incline"? State the conditions under which such "inclines" may be used, and the precautions to be adopted for the safety of the persons employed in connection with them. (Sketch required.)
36. Describe an ærial rope-way. In what circumstances is this method of haulage most suitable? (Sketch required.)

37. What are the chief causes of the deterioration of winding ropes, and what remedies are used ?
38. What horse-power is required to lift 18,000 gallons of water per hour from the bottom of an incline 1,500 yards distant from the shaft, the average gradient of the incline being 1 in 5 ? The friction in the pipes is to be neglected.
39. What effect has "splitting" the air on the ventilation of mines, and what benefits are to be gained by increasing the size of air-ways ?
40. Describe the construction of any form of gyratory rock and ore-breaker. (Sketch required.)

STAGE 3.

*Branch A.*

41. In what ways may the inclination and direction of a bore-hole be ascertained ? Give instances in which deviation from the vertical has been detected. (Sketch required.)
42. Give the composition of the explosive you would use, and describe how you would conduct the operation of shot-firing in a dry and dusty mine where gas is sometimes found.
43. Describe the manner in which steel frames may be used for colliery main roads, indicating the advantages and disadvantages of this method of support. (Sketch required.)
44. Describe fully the method in which cast-iron tubbing is applied to lining shafts, and state the conditions under which you would adopt it. (Sketch required.)
45. In opening a seam of coal, what considerations would influence you in deciding whether to work by a long wall or by a pillar and stall method ? (Sketch required.)
46. Describe the method of packing mine workings by the water-flush system, and discuss its advantages and disadvantages. (Sketch required.)
47. Describe a system of winding with an endless rope. (Sketch required.)
48. Describe two forms of electric pumps, one worked directly from the motor and the other with the intervention of gearing. (Sketches required.)
49. If the total quantity of air passing in a mine is 200,000 cubic feet per minute with a water-gauge of 6 inches, and the fan engine cylinder is 28 inches in diameter, with a mean effective steam pressure of 25 lb. per square inch, and a piston speed of 650 feet per minute, what would be the efficiency of the fan ?

50. What precautions would you adopt to guard workmen employed underground from possible accidents due to the use of electricity ?

*Branch B.*

51. In what ways may the inclination and direction of a bore-hole be ascertained ? Give instances in which deviation from the vertical has been detected. (Sketch required.)
52. Give the composition of blasting gelatine, and describe how you would conduct the operation of shot-firing with it. What precautions must be adopted to obviate the evil effects of dust and smoke after blasting ?
53. Describe the manner in which steel frames may be used for main levels underground, indicating the advantages and disadvantages of this method of support. (Sketch required.)
54. Describe fully the method in which cast-iron tubbing is applied to lining shafts, and state the conditions under which you would adopt it. (Sketch required.)
55. Describe two methods of working a thick body of ore, in which the removal of the mineral is complete. (Sketches required.)
56. Describe a magnetic separator suitable for the treatment of feebly magnetic ore. (Sketch required.)
57. Describe a system of winding from different depths with an endless rope. (Sketch required.)
58. Describe two forms of electric pumps, one worked directly from the motor and the other with the intervention of gearing. (Sketches required.)
59. If the total quantity of air passing in a mine is 200,000 cubic feet per minute with a water-guage of 6 inches and the fan engine cylinder is 28 inches in diameter with a mean effective steam pressure of 25 lb. per square inch and a piston speed of 650 feet per minute, what would be the efficiency of the fan ?
60. What precautions would you adopt to guard workmen employed underground from possible accidents due to the use of electricity ?

HONOURS.

*Instructions.*

You are not permitted to answer more than *five* questions.

NOTE.—*No Candidate will be credited with a success in this examination who has not obtained a previous success in Stage* 3 *or in Honours of the same subject.*

*Candidates for Honours must recollect that their answers are expected to be full and well illustrated; short answers illustrated by imperfect or insufficient sketches will not secure a pass.*

61. Enumerate some of the more remarkable instances in which the contents of mineral veins have been found to vary with the character of the rocks intersected by them.
62. Explain a system of timbering best adapted for obviating accidents from falls of roof and side (1) where coal-cutting machines are used, and (2) where the coal is got by hand.
63. Describe the method of lining circular shafts with concrete blocks. What advantages are claimed for this method compared with the usual bricking process?
64. Show in what manner a conveyor system may be applied for filling at a long wall working face.
65. Describe the manner in which stone is quarried by the aid of the wire saw.
66. Describe the method that you would recommend for capping (1) a locked-coil wire rope, and (2) an ordinary wire rope, in order to secure the most efficient results.
67. Give particulars of a plant in which electricity has been applied for winding in a main shaft, and discuss the difficulties that render it questionable if the present methods of winding will ever be entirely superseded by electricity.
68. What are the principal gases that pollute the air of mines? How can their presence be detected, and how can the amount of the more important be ascertained?
69. Enumerate the difficulties likely to arise in "earthing" electric cables in underground workings.
70. Discuss the comparative suitability of tube-mills and grinding pans for effecting the pulverisation of gold ores.

## GLAMORGAN TECHNICAL INSTRUCTION COMMITTEE.

### Mine Surveying.

### Elementary Stage, 1899.

1. Give the length of a link and of a chain. How many chains are there in a mile; how many square links in an acre; how many acres in a square mile?
2. Describe the miner's dial.
3. Show how you would book your sights and distances if you had to survey a district with headings, dips, and stalls.
4. What do you mean by magnetic North and true North? How would you proceed to fix both on your colliery plans?
5. Describe how you would make a needle survey underground for the purpose of driving two places to meet.
6. Describe a vernier to read to the $\frac{1}{100}$ of an inch, and one to read to three minutes.
7. How would you book a levelling of six sights, giving back sights, fore sights, distances, and levels reduced?
8. How do you take the height of a stack, given a chain and theodolite?
9. A vernier survey is made extending a length of one mile. You afterwards discover a mistake of a quarter of a degree has been made from the commencement. How much was the survey out at the end?
10. A is a seam 60 yards above B, and dipping due south at the rate of 3 inches per yard. A cross measures drift is driven due south dipping 5 inches per yard. What will its length be from A to B?

### Advanced Stage, 1899.

1. Why do you mark the protractor in an opposite direction to that on the miner's dial?
2. How would you proceed to fix your magnetic meridian? Upon what occasions would you check it?
3. In making a vernier survey, six sights are taken, and the angles between the lines are 170° 30′, 162° 15′, 140° 15′, 190° 15′, and 130° 00′, respectively. The angles are taken in the direction that the hands of a clock move. Reduce all the lines to angles off the first base.

4. You have a level, six-sided field. How can you fix each line :
   1. By measuring only one line and using the theodolite.
   2. By using the chain without the theodolite.
5. How would you measure the width of a river when standing on one side ?
6. How would you find the difference in level between two places underground ? What is meant by a bench mark, and a contour line ?
7. The following sights are taken in a levelling :

| *Back Sight.* | *Fore Sight.* |
|---|---|
| 5·61 | 8·90 |
| 6·40 | 10·20 |
| 1·03 | 7·86 |
| 5·12 | 1·03 |
| 3·01 | 8·99 |

   Show how you would book these sights, and reduce the levels to one total.
8. What is the quantity of coal in an acre of a seam 5 feet 3 inches thick ? Specific gravity of coal 1·25.
9. A right-angled triangle has its longest side 640 yards, and one of the other sides 421 yards. Find the length of the other side.

ELEMENTARY STAGE, 1900.

1. How do you find the area of a square, rectangle, circle, right-angled triangle, and isosceles triangle ?
2. Describe the ordinary level and levelling staff for making a levelling underground.
3. What is meant by the variation of a magnetic needle ? What is the variation this year ?
4. Show how you would book six back and six fore sights in a levelling book, and reduce the sights to a datum line.
5. Describe fully how you would proceed to put a point on a heading underground.
6. How many links are there in 100 yards ? How many chains in 20 miles ? How many square links in 12 acres ?
7. How would you proceed to make a magnetic survey underground of six sights ? Show how you would book your sights.
8. Supposing you were chaining a long line. Describe what you would do if you were in the exact line of chaining. How would you chain on hilly ground ?

9. A is a seam of coal 40 yards below B. The seams are dipping due south, 12 inches per yard. If I drive a hard heading level due north from seam B, how far must I drive it before meeting with A ?
10. Describe and sketch a vernier to read to three minutes. When is a vernier useful ?

### Advanced Stage, 1900.

1. A coal-field in shape is a rectangular parallelogram, the sides one mile and a half-mile respectively. It has three workable seams.

| | | | | |
|---|---|---|---|---|
| 1st seam | .. | 3′ 0″ thick | .. | 1·29 SG. |
| 2nd seam | .. | 2′ 9″ thick | .. | 1·29 SG. |
| 3rd seam | .. | 2′ 6″ thick | .. | 1·30 SG. |

Allowing 15 per cent. for faults, bad coal, and loss in working, what is the amount of coal ?
2. What is the area of a triangle whose 3 sides are 410 yards, 500 yards, and 520 yards ?
3. Describe how you would drive an engine plane on a curve of 3 chains radius.
4. How would you connect an underground survey with a surface survey ?
5. How many cubic yards are there in a tunnel 1 mile long, 12 feet wide, and 10 feet high ?
6. Describe fully how you would proceed to make a vernier survey.
7. How would you proceed to reduce a plan from the 2 chain scale to the ordnance ? Show by sketches, and, if possible, give more than one method.
8. Describe one method of measuring the width of a river standing on one side. How do you measure the height of a stack with the chain and theodolite ?
9. If you had to find out how deep your workings in a pit were under the bed of a river or public building, how would you proceed ?

### Elementary Stage, 1903.

1. A road dips 3 inches per yard for a quarter of a mile, and rises 1 inch per yard for 21 chains. What is the difference of level between your starting and finishing points ?
2. Explain the principle of the vernier, and describe one to read to the 1-100th of an inch.
3. Describe how you would take the width of a river, taking measurements only on one bank.

4. Describe how you would survey a six-sided field with the chain only.
5. Two points are 632 yards 1 foot from each other, and the difference in level is 51 inches. What is the gradient ?
6. How would you take the depth of a shaft, and draw a section of it ?
7. Describe how you would take six sights underground with a magnetic needle.
8. Make an imaginary page from a level book showing 12 readings and 6 settings of the instrument over undulating ground. Work out the readings you give.
9. A fault throws the coal up 21 feet 3 inches. What is the length of a hard heading to win the coal seam, rising 1 in $5\frac{1}{2}$ ?
10. Describe fully how you would put a point underground in an accurate manner.

ADVANCED STAGE, 1903.

1. A road rises 1 in 567·7 for a mile and dips 1 in 40 for 5 chains. What is the difference in level ?
2. You have a pentagon (5-sided figure) and one of the sides is pointing due north. Work out the direction of each of the other sides.
3. A circle is 10 feet in diameter. Work out the sides of the largest rectangle that could be inscribed, supposing the longer side to be 3 times the length of the shorter.
4. A stack is 50 feet high. The angle with the horizon from a certain station to the top is 30 degrees. What distance is the station from the base of the stack ?
5. Describe the variation of the magnetic needle. How often would you alter your points underground, and how would you allow for it, supposing your colliery plan lasted for 10 years ?
6. Describe how you make an underground vernier survey. Assuming your chaining to be correct, how would you check a survey three times to test the accuracy of the sights ?
7. Describe fully a vernier to read to one minute.
8. Describe fully the requirements of the Coal Mines Regulation Act when sending in plans of abandoned workings.
9. How many tons of coal are there under an acre of surface, the seam of coal being 4 feet thick, dipping 1 in 2, S.G. 1·2 ?
10. Describe how you would keep a levelling, book for back sights, intermediate and fore sights, and distances. Book an imaginary level with 6 fixings of the instrument and reduce the levels.

## COMPETITION FOR MINE INSPECTOR.

### REGULATIONS, EXAMINATION PAPER FOR 1891, AND TABLE OF MARKS.

#### SUBJECTS OF EXAMINATION.

1. Handwriting.
2. Orthography.
3. Arithmetic, including Vulgar and Decimal Fractions.
4. English Composition.
5. Theoretical and Practical acquaintance with Coal Mines and Mining.
6. A knowledge of Metalliferous Mines.

*Limits of Age*, 23-25.

No person will be qualified as a candidate who has not, within five years previous to his application, been employed for two years underground in a coal mine.

*An official nomination by the Home Secretary is required for this situation.*

#### TIME TABLE.

| Time of Examination. | | Subjects of Examination. |
|---|---|---|
| Thursday, 19th Mar... | 10 a.m. to 12 noon .. | Arithmetic. |
| | 12 5 p.m. to 12 35 p.m. | Copying. |
| | 12 40 p.m. .. .. | Dictation (1). |
| | 2 30 p.m. to 4 30 p.m. | English Composition. |
| | 4 35 p.m. .. .. | Dictation (2). |
| Friday, 20th „ | 10 a.m to 1 p.m. .. | *Coal Mining (1). |
| | 2 p.m. to 5 p.m. .. | *Coal Mining (2). |
| Saturday, 21st „ | 10 a.m. to 1 p.m. | *Metalliferous Mining. |

* In these subjects there will be an oral examination, the time and place of which will be notified to the candidates who take them up.

N.B.—Candidates failing to attend punctually will forfeit their right to be examined.

#### COPYING.

On the form supplied, copy as much as you can of the following in the prescribed time.

*Mexico.*

The accompanying table shows a comparison of distances to different points by the Isthmus Railway, and by other routes.

*Table of Distances.*

Advantages of the Tehuantepec Route.

| | Via Cape Horn. | Via Cape of Good Hope. | Via Suez Canal. | Via Panama Railway. | Via Isthmus of Tehuantepec. |
|---|---|---|---|---|---|
| From New York— | | | | | |
| To Hong Kong .. | 20,379 | 16,945 | 13,596 | 12,953 | 11,602 |
| „ Yokohama .. | 19,802 | 18,085 | 15,527 | 11,256 | 10,006 |
| „ Auckland .. | 13,890 | 18,719 | 16,871 | 10,305 | 9,424 |
| „ Melbourne .. | 15,215 | 15,019 | 15,171 | 11,826 | 11,065 |
| „ San Francisco .. | 15,687 | .. | .. | 6,063 | 4,890 |
| From New Orleans— | | | | | |
| To Hong Kong .. | 20,804 | 17,485 | 15,108 | 12,308 | 10,270 |
| „ Yokohama .. | 20,227 | 18,625 | 17,039 | 10,611 | 8,637 |
| „ Auckland .. | 14,314 | 17,259 | 18,381 | 9,659 | 8,090 |
| „ Melbourne .. | 15,640 | 15,560 | 16,683 | 11,181 | 9,736 |
| „ San Francisco .. | 16,112 | .. | .. | 5,418 | 3,561 |

Mr. Nimmo, in his report (1884) on the commerce between Mexico and the United States, remarks: "That although the agricultural products of Mexico are exceedingly diversified, the inhabitants can now exchange such products only upon the payment of transportation charges, which greatly restrain internal commerce, and which, with respect to a large part of the country, constitute an insuperable barrier to foreign trade. Wheat of the first quality is produced in a considerable portion of the country, but the cost of transport causes its price to be so high in other localities, as to place it beyond the means of the labouring classes. In some parts of the country it is difficult to procure wood for fuel, and in other places it is so abundant as to have no market value. Ebony, rosewood, mahogany, and cedar are used for fuel, for the reason that it is impracticable to transport them to the seaboard. These facts appear to indicate that the local traffic of the railroads in Mexico will be much larger and more profitable than the through traffic between the two countries."

The truth of these remarks is fully borne out by the traffic returns of the Central Railway, on which, as already stated, the local freight represented in 1887 70·19 per cent., and in 1886 70·93 of the whole. The local traffic could, no doubt, be greatly increased if facility of transport existed, other than that afforded by the railways.

Unfortunately, in Mexico there are but few made roads; those that exist, or were made by the Spaniards, have been allowed to go to ruin. Neither roads nor bridges are ever repaired, and any money granted for the purpose is rarely expended in the manner in which it was intended to be applied.

### Dictation. (1.)

The great Empire which England has established in the East will be the theme of wonder to succeeding ages. That a small island in the Atlantic should have conquered and held the vast continent of India as a subject province is in itself a fact which can never be stated without exciting astonishment. But that astonishment will be increased when it is added that this great conquest was made, not by the collective force of the nation, but by a company of merchants, who, originally vested with a charter of exclusive commerce, and with the privilege and right to protect their property by arms, were in a few years, through the enterprise and ambition of their agents, the hostile and rival spirit of the other nations of Europe, and the weakness and perfidy of the princes of Asia, to whom they became, from their encroachments or their riches, an object of jealousy or plunder, hurried into the possession of royal power, and actually found themselves called upon to act in the character of sovereigns over extended kingdoms before they had ceased to be the mercantile directors of petty factories. Those who look deep into the causes of great revolutions, and find them, not in the successful issue of the complex schemes of ambitious statesmen, but in the simple operation of natural and obvious causes, will perhaps discover that the means by which India was rendered subject to England (however inadequate they might at first glance appear) were, of all others, the most efficacious to secure that great object. Force and power could not have approached the shores of India without meeting with resistance; but to the unpretending merchant every encouragement was offered, and, when the spirit with which the early settlers defended their property from spoliation showed that they were as superior in their military as their commercial character, they became more an object of admiration than of jealousy to the principal powers of India.

### Dictation. (2.)

Dr. Arnold's great power as a private tutor resided in this, that he gave such an intense earnestness to life. Every pupil was made to feel that there was a work for him to do—that his

happiness as well as his duty lay in doing that work well. Hence an indescribable zest was communicated to a young man's feeling about life; a strange joy came over him on discovering that he had the means of being useful, and thus of being happy; and a deep respect and ardent attachment sprang up towards him who had taught him thus to value life and his own self, and his work and mission in this world. All this was founded on the breadth and comprehensiveness of Dr. Arnold's character, as well as its striking truth and reality; on the unfeigned regard he had for work of all kinds, and the sense he had of its value, both for the complex aggregate of society and the growth and perfection of the individual. Thus, pupils of the most different natures were keenly stimulated; none felt that he was left out, or that, because he was not endowed with large powers of mind, there was no sphere open to him in the honourable pursuit of usefulness. He had a wonderful power of making all his pupils respect themselves, by awakening in them a consciousness of the duties assigned to them personally, and of the consequent reward each should have of the labours of his youth. This power he possessed eminently at Rugby; and also, if the vivid recollections of friends may be trusted, he had it quite as remarkably afterwards. His hold over all his pupils was perfectly astonishing. It was not so much an enthusiastic admiration for his genius, or learning, or eloquence which stirred within them; it was a sympathetic thrill, caught from a spirit that was earnestly at work in the world, whose work was healthy, sustained, and constantly carried forward in the fear of God.

### ARITHMETIC.

(To Vulgar and Decimal Fractions.)

[You are requested to put the number to each question, and to send up the *working* as well as the answers. No extra credit will be given for completing your answers in less than the time allowed.]

1. Add together $13\frac{3}{7}$ and $11\frac{16}{21}$.
2. Subtract $17\frac{11}{18}$ from $21\frac{4}{27}$.
3. Multiply $4\frac{4}{35}$ by $\frac{+7}{48}$.
4. Divide $5\frac{17}{23}$ by $3\frac{87}{92}$.
5. Add together 466·25, ·7534, 20·06, and 2·26417.
6. Subtract 337·607452 from 351·0064.
7. Multiply 39·605 by ·802706.
8. Divide ·1817654 by ·0589.
9. Reduce $\frac{4}{9}$ of 1 day 13 minutes to seconds and the decimal of a second.

10. In 8680267 square inches how many acres, roods, perches,&c.?
11. If $\frac{31}{32}$ of a share in an undertaking is worth 16 guineas, what is the value of $1\frac{3}{8}$ shares ?
12. Find (by practice) the value of 1,368 articles at 16s. $4\frac{1}{4}$d. each.
13. What is the simple interest on £2,075 10s. for 3 years at $2\frac{1}{2}$ per cent. per annum ?
14. Add together $13\frac{11}{16}$, $\frac{31}{45}$, $9\frac{7}{15}$, and $5\frac{19}{72}$.
15. Subtract $48\frac{13}{15}$ from $57\frac{17}{17}$.
16. Multiply together $2\frac{1}{84}$, $\frac{38}{75}$, $2\frac{21}{52}$, and $13\frac{5}{19}$.
17. Divide $8\frac{14}{33}$ by $6\frac{50}{43}$.
18. Add together ·327 of 2 qrs. 12 lb., and ·045 of 3 cwt., and express the answer in ounces and the decimal of an ounce.
19. Express the difference between ·87 of 2 lb. 10 ozs. 10 dwts. and 2·14 of 3 ozs. 14 grs. in grains and the decimal of a grain.
20. Multiply $0{\cdot}5\dot{4}5\dot{0}$ by $0\dot{1}\dot{8}$, and express the answer as a decimal.
21. Divide $2{\cdot}9\dot{8}0\dot{1}$ by $7{\cdot}4\dot{5}0$, and express the answer as a decimal.
22. Express 3 pecks 1 quart as the decimal of a bushel.
23. Reduce $1\frac{3}{4}$ furlongs to inches.
24. What decimal fraction forms a fourth proportional to 111, 14·8, and $\frac{9}{500}$ ?
25. Find (by practice) the cost of 7 lb. 5 ozs. 10 dwts. at £3 2s. 6d. per lb.
26. Find the compound interest on £3,745 in 3 years at 4 per cent. per annum (fractions of a penny may be neglected).

---

### Subjects for English Composition.

[You should pay attention to your spelling, punctuation, grammar, and style. Your composition should fill at least two pages, but it will be valued according to the quality rather than the quantity.]

Write an essay on *one* of the following subjects :—

1. English Coal and Iron ;

Or,

2. The dangers of work underground ;

Or,

3. Combinations of Employers and of Workmen.

### Coal Mining. (1.)

1. What are the principal divisions of the Carboniferous System, and in which of them is coal found ?

2. Which of the British coal-fields are partially covered by newer strata ?
3. What are steam coal, gas coal, and anthracite, and how do they differ in composition and character ?
4. How is coal proved in a new locality ?
5. Describe a method of securing a large level used as a main haulage road.
6. How would you sink a pit in ground requiring tubbing ?
7. What methods have been proposed for blasting with explosives without flame ?
8. What is the lime cartridge method of breaking down coal ?
9. What are the most efficacious methods of preserving timber underground ?
10. Describe the system of working coal by a long wall method.

COAL MINING. (2.)

1. Compare the principal methods of guiding cages in shafts.
2. What are safety catches ? Explain the construction of some of them.
3. How can the load on the winding engine be equalised in a deep mine ?
4. Describe the composition and properties of the gases given off by coal.
5. How is fire-damp detected in the air of mines ?
6. Give an account of two good forms of safety-lamp.
7. How are air-currents split and crossed underground ?
8. What are open-running and enclosed fans ? Give an example, with some details of each kind.
9. How is the efficiency of a ventilating machine determined ?
10. Compare the main and tail haulage rope and endless chain systems of underground haulage.

*** *In this subject there was also an oral examination.*

METALLIFEROUS MINING.

1. What is tin ore, and how is it found ?
2. What iron ores are found in the United Kingdom ?
3. What is a lode, and what terms are used in describing it ?
4. What are the principal methods of working on lodes ?
5. What is the waterfall blower, and what is its mechanical efficiency ?
6. How is the ventilation of a mine on a lode usually effected ?
7. How should the ladders be arranged for convenience and safety in a footway shaft ?
8. What are the principal kinds of man engines in use in mines ?

9. How are the pumps and pit work arranged in a shaft of varying inclination ?

10. Describe any metalliferous mining district with which you are acquainted.

*** *In this subject there was also an oral examination.*

TABLE showing the results of an Examination held on the 19th and following days of March, in the Year 1891, of Candidates nominated to compete for one assistant Inspectorship of Mines.

| NAME. | Arithmetic. | Orthography. | Handwriting. | English Composition. | Theoretical and Practical acquaintance with Coal Mines and Mining. | A knowledge of Metalliferous Mines. | Total. |
|---|---|---|---|---|---|---|---|
| Maximum ... | 150 | 100 | 100 | 150 | 1000 | 300 | 1800 |
| No. 1 ... ... ... | 79 | 50 | 75 | 100 | 605 | 135 | 1044 |

Examinations for these appointments do not take place at fixed intervals, but are held from time to time as candidates are nominated by the Home Secretary to fill the vacancies which occur. The Civil Service Commissioners are authorised by the Secretary of State to make the following announcement :—

Applications for the post of Inspector of Mines addressed to the Home Secretary will be considered from time to time as occasion may arise for fresh nominations to be made. In the event of more than one candidate being nominated to a single vacancy, and the examination being thus made competitive, the candidates will be so informed at the time they are nominated.

Civil Service Commission,
11th October, 1893.

## HOME OFFICE EXAMINATION.

### REGULATIONS AND SYLLABUS FOR FIRST AND SECOND CLASS CERTIFICATES.

*This synopsis of Regulations and Syllabus is given as arranged by Professor Redmayne in the "Colliery Manager's Pocket Book," a diary which should be in the possession of every colliery official.*

These are changed from time to time. Candidates therefore are strongly advised to apply to the Secretary of the Board of Examinations for the district in which they propose to sit, at the beginning of their career, and again two or three years before the date of their examination. In several cases neglect to do this has resulted in a serious loss of time.

The following are some particulars of age, place, and experience required and the subjects of examination, together with the month in which the examinations are held, in the respective inspection districts.

#### SCOTLAND, EAST. (*Edinburgh. May.*)

Candidates must be over twenty-three years of age, have had five years' practical experience in a mine, and be able to write in a fair and legible manner. A period of apprenticeship to a mining engineer may be substituted as an alternative for an equivalent period of regular employment in a mine under the Act, if the apprentice has in the discharge of his duties to go down mines and obtain practical experience therein.

*First-class certificates.*—1. The Coal Mines Regulation Act, 1887, general knowledge of. 2. Ventilation, theoretical and practical knowledge of. 3. Modes of working coal, ironstone and other minerals, having reference to the nature of the roofs and pavements. Candidates must have some knowledge of both the long wall and the stoop and room methods of working. 4. Sinking, fitting, and pumping, with theory of steam engine. 5. Winding, haulage, and strength of materials. 6. Underground surveying and drawing. 7. Arithmetic, up to fractions, with calculations of areas and velocities.

*Second-class certificates.*—1. The Coal Mines (1887) Act sections 4 to 13, 21, 35 and 49 to 50. 2. Ventilation, theoretical

and practical knowledge of. 3. Modes of working coal and other minerals, having reference to the nature of the roofs and pavements. Candidates must have some knowledge of both the long wall and stoop and room methods of working. 4. Sinking, fitting, and pumping, with knowledge of machinery and boilers in use at collieries. 5. Winding, haulage, and strength of materials. 6. Underground surveying and plotting on surface. 7. Arithmetic, first four rules (simple and compound). The subjects 4, 5, 6, and 7 are optional for second-class candidates.

Scotland, West. (*Glasgow. November.*)

Applicants must be above twenty-three years of age, and must have had practical experience in a mine for at least five years. (A period of apprenticeship to a mining engineer cannot be substituted as an alternative for the above qualification, unless the apprentice has in the discharge of his duties regularly to go down mines and obtain a practical experience therein.)

*First and second-class certificates.*—1. Mines Regulation Acts, 1887 and 1896, general knowledge of. 2. Ventilation, theory and practice. 3. Sinking, fitting, and pumping, including timbering of shafts. 4. Winding and haulage. 5. Modes of working coal, ironstone, or other mineral, having reference to the nature of the roofs and pavements and setting off the workings of a new pit, including also timbering of workings. 6. Surveying and drawing. 7. Arithmetic up to vulgar fractions, including calculation of areas and velocities.

Newcastle District. (*Newcastle-on-Tyne. January.*)

The candidate must be twenty-three years of age or upwards. *For first-class certificates.*—Actual practical experience for at least five years as under-manager, underviewer, assistant viewer, fore overman, back overman, master shifter, or master wasteman. But at least two years' experience in any of these capacities will be deemed sufficient in the case of a candidate who during two years has held a second-class certificate. Two years' or three years' apprenticeship to a mining engineer, with evidence that such period afforded substantially practical experience in a mine, shall be regarded as a substitute for an equivalent period of such employment. *For second-class certificates.*—Practical experience in a mine for at least five years, which shall include, in addition to the foregoing employments, that of deputy overman, master shifter, master wasteman, or practical working miner.

*First-class certificates.*—Ordinary education: Reading, writing, and arithmetic. Engineering: General principles, including pumping, &c. Practical mining: Mode of sinking, working, timbering, bratticing, and ventilation. The nature and properties of gases. To know the duties of a manager as described in the Mines Act.

*Second-class certificates.*—The same subjects as above so far as they are suitable for practical working miners.

DURHAM DISTRICT. (*Darlington. July.*)

The candidate must be twenty-three years of age or upwards. *For first-class certificates.*—Actual practical experience for at least five years as underviewer, assistant viewer, fore overman, back overman, master wasteman, or master shifter. But at least two years' experience in any of these capacities will be deemed sufficient in the case of a candidate who during such two years has held a second-class certificate, such certificate to be forwarded to the secretary of the Board. Two years' or three years' apprenticeship with indenture to a mining engineer, with evidence that such period afforded substantially practical experience in a mine, shall be regarded as a substitute for an equivalent period of such employment; articles of indenture to be forwarded to the secretary of the Board. *For second-class certificates.*—Practical experience in a mine for at least five years, which shall include, in addition to the foregoing employments, deputy overman, master shifter, master wasteman, or practical working miner.

*First-class certificates.*—1. Writing and arithmetic. 2. Nature and properties of gases, such as giving a description of the characteristics of those met with in mines, how their presence can be ascertained, and what precautions should be taken to prevent their accumulation, or removal if they do accumulate. How the quantity of air in any air-way can be ascertained. 3. General engineering principles, including surveying and strength of materials, properties of steam and water, and elementary electricity. 4. Practical mining, including principles of ventilation, sinking, working, timbering, bratticing, boring on approaching old workings, also machinery and boilers in general use at collieries. 5. The general rules of the Coal Mines Regulation Act, 1887, the special rules of this board's mining district, the Explosives Act, the Boiler Explosions Acts, 1882 and 1890, and some knowledge of ambulance work. 6. Geology, especially in the mining district of this board.

*Second-class certificates.*—The same subjects as above so far as they are necessary for practical working miners.

Yorkshire and Lincolnshire District. (*Leeds. June.*)

No person under the age of twenty-three years is eligible in either class. No candidate who is examined only for a first-class certificate can be allowed to obtain a second-class certificate at the same examination. Under the Coal Mines Regulation Act, 1887, no person shall be entitled to a certificate (in either class) unless he shall have had practical experience in a mine for at least five years. A period of apprenticeship to a mining engineer cannot be substituted as an alternative for an equivalent period of regular employment in a mine under the Act unless the apprentice has in the discharge of his duties to go down mines and obtain practical experience therein.

*First-class certificates.*—1. Arithmetic: The first four rules; vulgar and decimal fractions; extraction of square and cube roots. 2. Ventilation: Common air and gases; different methods of ventilation. 3. The use of instruments for surveying and dialling and levelling (dialling by both fast and loose needle), and the testing of instruments for surveying. Plotting surveys and making plans and sections. 4. The winning and working of coal mines. 5. Practical mechanics. 6. The Coal Mines Regulation Act, 1887, and the special rules in force in this district.

*Second-class certificates.*—1. Reading and writing. 2. Arithmetic: The first four rules. 3. Ventilation: Common air and gases; different methods of ventilation. 4. The use of the anemometer, barometer, thermometer, and water-gauge. 5. The Coal Mines Regulation Act, 1887, and the special rules in force in this district.

Manchester and Ireland. (*Manchester. December.*)

Each candidate must be twenty-three years of age. He must have had five years' practical and other experience in a mine, subject to the Coal Mines Regulation Act, 1887, and he must be able to read and write.

*First-class certificates.*—1. Arithmetic, including vulgar and decimal fractions and square root. 2. Practical mechanics, including a knowledge of the management of steam engines, boilers, and pumps. 3. The Coal Mines Regulation Acts, 1887 and 1896, and the special rules in force in this district, also the Explosives in Coal Mines Order of September 10, 1901. 4. The practical working of collieries, colliery surveying and levelling, with special reference to the methods practised in

this district. 5. Mine gases, and the principles and practice of lighting and ventilating coal mines. Candidates will also be required to satisfy the examiners that they understand a plan and section, also to show how they would ventilate workings on a plan to be produced to them.

*Second-class certificates.*—The examination and qualification for second-class certificates will be suitable for practical working miners, and will be such as to ascertain, partly by written and partly by oral examination, the knowledge necessary for the practical working of mines in this district. The following will be the heads under which the examination will be held:—1. Reading, writing, and arithmetic—first four rules. 2. Knowledge of the Coal Mines Regulation Acts, 1887 and 1896, and the special rules in force in the district. 3. The practical working of coal mines as carried out in this district. 4. Mine gases and practical ventilation. Upon application to the secretary, unsuccessful candidates for either first or second class certificates can obtain information as to the subjects in which they have failed.

LIVERPOOL DISTRICT. (*Wigan. June.*)

Each candidate must be twenty-three years of age. He must have had five years' practical experience in coal mining. He must have a fair elementary education.

*First-class certificates.*—The practical working of mines in the mining district of West Lancashire and North Wales, including the provisions of the Coal Mines Regulation Act, 1887, the Explosives in Coal Mines Order of 10th September, 1901, the principles of mechanics and surveying, and the subject of electricity as applied to the working of coal mines. The attention of the candidate is directed to "Goodeve's Principles of Mechanics" (published by Longman's and Co.), or other text-book on the same subject; "A Practical Treatise on the Gases met with in Coal Mines and the General Principles of Ventilation," by J. J. Atkinson (published by Longmans).

*Second-class certificates.*—The examination and qualification for second-class certificates will be suitable for practical working miners, and will be such as to ascertain, principally by oral examination, the knowledge necessary for the practical working of mines in this district.

The following are the heads under which the examination is held:—1. Reading, writing, and arithmetic. 2. Knowledge of the Coal Mines Regulation Acts, and the special rules in force

in the district, and Explosives Order above-mentioned. 3. The various systems of working coal. 4. Modes of sinking, working, timbering, bratticing, ventilation, and surveying.

MIDLAND DISTRICT. (*Nottingham. October.*)

No candidate is eligible for examination until he is twenty-three years of age. He must have had practical experience in a mine for at least five years.

*First-class certificates.*—1. Writing (upon the Coal Mines Regulation Acts, and the special rules of the district in which the candidate resides). 2. Arithmetic. 3. The winning and working of mines of coal, mines of stratified ironstone, mines of shale, and mines of fire-clay. 4. Machinery. 5. Ventilation. 6. Safety of miners, and opening works after having been closed for a period. 7. Surveying and plans. 8. The treatment of injured persons, as recommended by the St. John Ambulance Association. (Candidates holding certificates from Government Science and Art Classes, or from the Nottingham University College, or the St. John Ambulance Association, should produce them to the examiners at the examination.) The candidates will be examined in reading, and also *viva voce* upon all the foregoing subjects. Upon the question of the qualification of candidates for first-class certificates, the board for examinations has passed the following resolution:—"That, in their opinion no candidate shall be considered to have a practical experience in a mine for five years, unless he has been for that time regularly engaged in connection with actual colliery management."

*Second-class certificates.*—1. Writing (upon the Coal Mines Regulation Acts, and the special rules of the district in which the candidate resides). 2. Reading. 3. Arithmetic. 4. Use of the anemometer, barometer, and water-gauge. 5. Ventilation and the use of safety-lamps. 6. The practical working of mines (*viva voce* examination). 7. The treatment of injured persons, as recommended by the St. John Ambulance Association. (Candidates holding certificates from Government Science and Art classes, or from the Nottingham University College, or from the St. John Ambulance Association, should produce them to the examiners.)

STAFFORDSHIRE (*April*).

No candidate is eligible for examination until he is twenty-three years of age, either for a first or second-class certificate. Subject to Mines Regulation Act, must have had five years' practical experience in a mine.

*First-class certificates.*—1. Elementary chemistry, confined to the gases of the mine, in all its practical bearings; the use and various types of safety-lamps; and coal-dust as an explosive agent; elementary general geology, and treatment of injured persons, as recommended by the St. John Ambulance Association, and a knowledge of ambulance work. 2. General knowledge of machinery as applied to colliery purposes; elementary electricity and the fencing of mid-insets; signalling in shafts and on underground engine roads and inclines. 3. Arithmetic, surveying, sinking pit, and laying out a colliery under various circumstances. 4. Underground management, practical ventilation, timbering, and shot-firing and general knowledge of explosives (*viva voce* in the above).

*Second-class certificates.*—1. Gases as found in the mine, and the use of safety-lamps, and the treatment of injured persons, as recommended by the St. John Ambulance Association. 2. Practical knowledge of machinery as applied to colliery purposes, and elementary arithmetic. 3. Sinking pits, surface and underground management, practical ventilation, timbering, and shot-firing (*viva voce* in the above).

SOUTHERN DISTRICT. (*Bristol. September.*)

Candidates must be twenty-three years of age, and are required to produce to the examiners a statement showing that within the last ten years the candidate has not had less than five years' experience of colliery operations, and that during at least two years out of the five he has been engaged at general underground work. It is essential that at least one testimonial should certify that candidates have had experience in the practical use of safety-lamps underground, and that they have had experience in the supervision, or assisting in the supervision, of the workings in fiery mines where safety-lamps are required to be used. A working plan of workings, and section of strata, both drawn to scale, must be produced, with the original survey book corresponding thereto, of some colliery, or portion of a colliery, known to the candidate. Both plan and section must be made by the candidate himself from his own actual survey and measurements. The section to become the property of the Board.

*First-class certificates.*—Arithmetic. Geology and surveying. Gases, and the ventilation of mines. Practical mining, safety-lamps and their practical use, colliery plant and machinery, mine accidents and their prevention. Mines Regulation Act

and Special Rules. *Viva voce* on the above subjects and general management of a colliery.

*Second-class certificates.*—1. Reading from print and ordinary manuscript. 2. Writing from dictation. 3. Arithmetic as applied to ordinary calculations of weights, measures, and wages, and as required for measuring ventilating air-currents, and for any other calculations connected with an under-manager's duties. 4. To write or describe by word of mouth the mode of working a colliery with which the candidate is acquainted. 5. Properties of gases met with in mines; the use of the barometer and thermometer. 6. The ordinary methods of ventilating mines. Best methods in dealing with dangerous conditions of the atmosphere of mines. Mode of procedure when ventilation is deranged from any cause. 7. Timbering roadways and working places. 8. Methods of working thick and thin seams of coal in steep and flat measures. 9. Ordinary system and arrangements for sinking shafts. 10. Machinery ordinarily used in or about a colliery. 11. Colliery accidents and their prevention. 12. Safety-lamps. 13. Mines Regulation Act, 1887, and special rules of the district. 14. *Viva voce* on the above subjects.

### Wales (*Cardiff. May.*)

Candidates for examination for a first-class certificate must be at least twenty-three years of age, and have had actual experience for at least five years, during which period the candidate must for at least one year have held either a second-class certificate or the post of under-manager, overman, day or night fireman. Three years' or upwards apprenticeship to a mining engineer, with evidence that during such period practical experience in a mine was obtained, shall be considered as forming a portion of the five years' experience referred to above, and for the purpcses of this examination equivalent to holding a second-class certificate. Candidates for examination for a second-class certificate must be at least twenty-three years of age, and must have had five years' practical experience in a mine.

*First-class certificates.*—1. Geology of the South Wales coal-field. 2. Arithmetic. 3. Working and winning of coal, stratified ironstone and fire-clay. 4. Mines Act, 1887 and 1896. 5. Practice and theory of ventilation. 6. Practical knowledge of the machinery and boilers generally in use at collieries. 7. Surveying.

*Second-class certificates.*—1. Simple arithmetic. 2. Mines Act 1887 and 1896. 3. Working coal. 4. Practical ventilation.

## HOME OFFICE QUESTIONS.*

CARDIFF (1ST CLASS), 1906.

*Machinery.*

1. What is the object to be gained by compressing air in high-pressure and low-pressure cylinders to a pressure of 120 lb. ? What advantages are there in using an inter-cooler ?
2. You have a seam of coal at 52 yards above the pit bottom ; the output, 250 tons per day, is to be let down by a self-acting incline. Give the inclination, laying out of roadways, top, bottom, and passing place, and give all other details.
3. A haulage road is 1,000 yards long, with an inclination of 5 inches per yard ; output 100 tons per hour. Give size of hauling engine, horse-power, and other details.
4. Describe and sketch the best form of shackle you have a knowledge of. Give your reasons why so many accidents occur in the use of shackles.

*Coal Mines Act.*

1. What does the Coal Mines Act say with regard to :—
   (*a*) Inspection by workmen ;
   (*b*) Lamp station ;
   (*c*) Manholes ?
2. What does the Explosive Order say with regard to detonators ; and what does the Order mean by the terms "road" and "main haulage road" ?
3. What do the special rules of your district say with regard to the duties of :—
   (*a*) Haulier ;
   (*b*) Pitman ;
   (*c*) Ventilating engineman ?
4. State briefly what you would do in the case of the abandonment of a mine.

*Ventilation.*

1. What device do you know of for the locking of safety-lamps ? State which you prefer. Describe it in detail, and give your reasons.
2. There are four splits, and one is taking more than its share of air. How many courses are there open to remedy this ? Which do you prefer, and why ?

* These questions are not published by the examiners, hence the difficulty experienced in giving the exact words and figures.

3. A seam of coal is worked in five splits, and there are 150,000 cubic feet of air per minute passing. Two splits are to the rise, and three to the dip. Output as follows :—

| | | |
|---|---|---|
| No. 1 | 170 | tons |
| No. 2 | 280 | ,, |
| No. 3 | 370 | ,, |
| No. 4 | 304 | ,, |
| No. 5 | 210 | ,, |
| | 1334 | ,, |

Each man produces on the average 3½ tons per day. Make a sketch of the working, showing how you would ventilate it, showing air-crossings, doors, and return air-ways.

4. A current of air has a velocity of 8 feet per second. State what size air-ways you would have to pass 15,000, 18,000, 22,000, 25,000, and 28,000 cubic feet of air per minute respectively.
5. What percentage of gas does a cap of ¼ inch represent ? What cap would you allow before withdrawing the workmen ?

*Arithmetic.*

1. The diagonal of a rectangular field is 20 chains 25 links, and the perpendicular from the opposite angles upon it are 8 chains 20 links, and 7 chains 9 links. What is the area of the field in acres, roods, and perches ?
2. Find to the nearest penny the value of ·288358 of £1,785 16s. 9d.
3. Multiply ·00653 × ·066384, and divide by ·0727.
4. Find the square root of 853,672.
5. Required standage room for water for 20 hours per day, at 250 gallons per minute. Find the cubical contents of the standage room.

*Practical Working.*

1. How would you work the following seam :—

*Roof.*—Strong cliff.

| | Ft. | in. |
|---|---|---|
| Top coal | 3 | 0 |
| Hard stone | 2 | 4 |
| Bottom coal | 2 | 0 |
| | 7 | 4 |

*Bottom.*—Bastard fire-clay.

Give your reasons for the plan you would adopt.

2. Two shafts are sunk in the middle of an undertaking. Give a general plan showing how you would set out the main haulage roads. Also give detailed sketches of the arching at pit bottom, laying out of the roadways, partings, &c.
3. Required to roof a pit 25 yards high from the face of the heading shown. The shaft is 10 feet diameter, how would you do it? Show sketches of the walling and arching.
4. A piece of a haulage road, 8 feet wide, 5 feet 6 inches high, has the timbers broken and roof weighting heavily upon them. State how you would proceed to repair this, and make it 12 feet wide and 7 feet 6 inches high, without interfering (only as little as possible) with the traffic, and safety of the workmen.
5. Given a section of a coal seam, under what circumstances would you adopt the use of coal-cutting machines? What direction to the slips would you drive your headings?

*Surveying.*

1. Two shafts, 278 yards deep, are sunk to a seam of coal 6 feet. A level is driven due east for 137 yards, and then it meets a fault, which is 57 yards along the slope, and dips 72° 30′ to the horizontal. What would be:—
   (*a*) Length of hard heading from the pit to top of fault?
   (*b*) What would be its magnetic bearing?
   (*c*) Allowing $\frac{1}{2}$ inch per yard for drainage, at what depth in the shaft would you have to start the heading?
2. What is meant by the vernier? Describe its use.
3. If you are working towards old workings whose plan is dated 1832, what precautions would you take to prevent accidents in striking them?
4. What is meant by a scale of $\frac{1}{2500}$?
5. What is the area of a pillar, whose scale on the plan is 1 inch = 208·32 feet, and which measures 2 inches by 2 inches?

*Geology.*

1. Place the following in sequence:—Old Red Sandstone, Chalk, Magnesian Limestone, Great Oolite, Silurian, Mountain Limestone, Coal Measures.
2. What percentage of fixed carbon would you expect to find in the best Welsh steam coal, and what per cent. of volatile matter would you expect in a good coking coal?

3. In driving headings you meet with the following disturbances:—How would you proceed in search of the coal? (Drawing given.)
4. Give sketches illustrating the south outcrop from Margam to Pontypool, and the north outcrop from Merthyr to Llandebie.

---

Cardiff (1st Class), 1905.

*Arithmetic.*

1. Multiply $\frac{1}{2} \times 3\frac{1}{7} \times \cdot 7854 \times 1 \cdot 344 \times 2 \cdot 12 \times \frac{1}{7} \times \frac{7}{11 \cdot 6} \times \cdot 632$.
2. A beam is 12 inches wide × 12 inches deep and 10 feet long. What is the weight?
3. A Lancashire boiler, 30 feet by 7 feet 6 inches diameter, with 2 tubes, 2 feet 10 inches × 6 cross tubes 12 inches diameter, is full of water to within 1 foot of the crown. What is the number of gallons contained in the boiler?
4. A person had the offer to buy scantling, 9 inches by 3 inches, at 4d. per lineal foot. Also a log of timber, 1 cubic foot for 1s. 8d. + 5 per cent. for sawing. Which is the cheaper, and by what percentage?
5. A piece of rock is worked for 10s. per cubic yard. A seam of coal 1 cubic yard is worked out at 1s. 10½d. per ton + 38¾ per cent. + full per cent. for yardage, making the coal 2s. 3d. per ton + 38¾ per cent. What is the price per ton of the coal, allowing 19 cwt. 2 qrs. to the cubic yard?

*Mines Act.*

1. State General Rule 1. What does it mean?
2. If you were in charge of a mine, and found an accumulation of gas, what would you do? State what the Act and special rules say with regard to the same.
3. What books and registers are required to be kept at a mine, and who are the persons to be specially nominated in writing?
4. What does the 1902 Act say with regard to the use of explosives in mines?

*Machinery, &c.*

1. What kind of a joint would you use for a range of steam pipes 10 inches diameter, with a pressure of 120 lb.? Explain how you would fix them.
2. What would guide you in adopting the endless rope system of haulage over the main and tail rope? What are the advantages and disadvantages?

3. A pair of drifts 1,000 yards long, dipping 3 inches per yard, and working 300 tons per day. The quantity of air passing is 60,000 cubic feet, with W.G. of 3 inches. At 100 yards down the quantity of water is 100 gallons per minute, and 150 gallons at the face of the drift. Give H.P. of each engine, and if 35 H.P. were required for other purposes, give number of boilers required. Show by sketch the arrangement of same at surface.

*Geology.*

1. What is an overlap? Sketch the same.
2. What is a dyke, and what effect has it on the strata and coal in contact with the same?
3. Give a description of the South Wales coal-field, giving the names of the kinds of coal found, with the thickness of each; also a section from north to south.
4. Give particulars of a seam found in the coal-field with the different formations found underneath the same, and the approximate thickness of each formation.

*Ventilation.*

1. Describe and give neat sketches of the best safety-lamp for use in a fiery mine, and state where you would lock, examine, and relight lamps.
2. In an airway, 12 feet by 7 feet, the velocity, which is 500 feet per minute, is charged with an explosive mixture at its most explosive point. What is the quantity of air required to dilute the current so that it would not show a cap on the flame of a safety-lamp?
3. The quantity of air passing through an air-way is 80,000 cubic feet, with a W.G. of 1·75 inches. What is the H.P. in the air, and if the velocity is increased to 100,000 cubic feet, what would be the W.G., other conditions remaining the same?
4. Show the workings of a fiery mine on the long wall principle in which an upthrow fault of 12 yards is met with, cutting all the workings except one stall, driven through the fault with a top hole. Show how you would proceed to open the workings on the other side of the fault, showing doors, &c., and the course of ventilation. The coal is won on the other side of the fault by a cross measure heading rising 3 inches per yard. Show how you ventilate the heading and the top hole.

*Practical Working.*

1. What means have been adopted to do away with the use of explosives in mines? Are they successful?

2. A mine giving off fire-damp freely, with no dust, and a mine giving off fire-damp, but very dusty. Which do you consider the more dangerous? Give reasons for your answer.
3. Give sketch of a working on the long wall principle, dipping 3 inches per yard; show the direction of the cleavage, arrangements of the ventilation, with position of air-crossings, doors, stoppings, regulators, &c.

*Surveying.*

1. A heading driven due north, dipping 3 inches per yard, the average dip of the coal-field. A heading was turned off due east. After being driven 100 yards it meets with an upthrow fault of 10 yards going in the direction of the main heading. What length of cross measure heading will be required by going level course to reach the coal on the other side of the fault?
2. What does the Act say in reference to surveys, levels, plans, &c.?
3. How would you make a survey with a theodolite in a working driven to the boundary, and how would you proceed to connect it with the surface plan?
4. The following are the entries in a levelling book:—Section commencing at A 50 feet above datum line.

| *Back sight.* | *Intermediate sight.* | *Fore sight.* |
|---|---|---|
| *10·00 | 8·52 | |
| | 7·40 | |
| 11·22 | | 5·00 |
| | 7·09 | |
| | 3·96 | 1·30 |

The distances are A to b 83; b to c, 100; c to d 78; d to e 47; e to f 30; f to G 29. These are links, the vertical measurements being in feet.

Reduce the levels, and plot the section. Horizontal scale 2 chains = 1 inch. Vertical scale 20 feet = 1 inch.

---

CARDIFF (1ST CLASS). 1903.

1.—*Machinery.*

1. Describe with sketches the various systems of haulage used underground.
2. Describe the various kinds of detaching hooks. Which do you prefer? What does the Coal Mines Regulation Act state with regard to detaching hooks?

---

*The question was of this nature, but the exact figures are not given.

3. If you have a pair of engines with cylinders 23 inches diameter and 4 feet stroke, what quantity of coal would it be possible to haul up a drift 2,500 yards long and dipping 1 in 6? And what should be the diameter of drum? Available steam pressure is 60 lb.
4. Which do you consider the best boiler and fittings for the economical production of steam at collieries? Give a sketch, with dimensions, of the one you prefer.

2.—*Arithmetic.*

1. A company acquire a taking of coal at a royalty of sixpence per imperial ton. At what rate per ton of 2,520 lb. of large coal must it be sub-let to produce a profit of one penny per imperial ton of gross coal? Percentage of large is 75, and the price paid for small is half that for large coal.
2. Reduce 3·1416 to a vulgar fraction. Reduce $\frac{8}{9}$ and $\frac{15}{16}$ to decimals. What is the cube of ·36 and the square root of 625?
3. Two shafts, one 20 feet diameter and the other 18 feet 6 inches diameter, have been sunk to a depth of 200 yards below the collar-board. They are both filled with water. When 500,000 gallons have been pumped from each, what is the distance from the collar-boards to the surface of the water in each shaft?
4. A drum is 6 feet diameter and 2 feet 6 inches wide. There are 60 coils of rope upon it. The rope is one inch in diameter. What length of rope is coiled upon the drum?

3.—*Practical Working.*

1. Select one of the following sections of seams:—

| A. | B. | C. |
|---|---|---|
| | Top clift. | |
| | Clod, 12 inches. | |
| ? | Coal, 3 feet 6 inches. | ? |
| | Rashings, 6 inches. | |
| | Bottom fire-clay. | |

A is worked pillar and stall. B long wall. C Barry, or Nottingham system.

Select A, B, or C, and describe how you would work the seam. The dip in each is 1 in 18. Give particulars on the following points:—

(1) The number of colliers you would employ (men and boys).
(2) The quantity of air you would require.
(3) The distance travelled by each place per fortnight.
(4) The number of firemen required.

Draw a plan on a scale of 20 feet to an inch showing 60 yards of heading, with modes of ventilation and timbering.
The gross output is 4,000 tons weekly.

2. Draw sketches of a double parting at the inbye end of a a plane worked by main and tail, and at the pit bottom. The engine is underground. The gauge is 3 feet, and the tram is 6 feet long over all. The dip, both inbye and at pit bottom, is 1 in 36 in favour of the load. Each parting should hold 20 trams. Show position of engine and pulley, return pulley for tail rope and roads and positions of full and empty trams.
3. Under what circumstances would you advocate putting in arches in main roads? Describe briefly the kind of arch you would adopt.
4. Describe how you would lay out the working in steep measures for an output of 150 tons per day, the section being—top clift clod, 10 inches; coal, 3 feet 6 inches; rashings, 6 inches. Dip, 1 in 3.
5. A steam colliery produces 1,200 tons per day. The seam is as follows:—Clift top; clod, 10 inches; coal, 4 feet. Dip, 1 in 18. Average distance from pit bottom to faces is 1,500 yards. If you were manager what system would you adopt as to firemen's reports and examination of safety-lamps?

### 4.—*Geology.*

1. Describe the appearance and give an average analysis of the following coals:—(*a*) Anthracite, (*b*) bituminous, (*c*) steam.
2. Trace the north outcrop of the coal-field in Carmarthenshire, and the anticlinal in Glamorganshire.
3. Where in the South Wales coal-field is the greatest number of coal seams to be found, and at what depth approximately do you estimate the lowest seam would be reached?
4. Describe briefly the strata you would pass over in walking from Cardiff to Brecon *via* Pontypridd and Merthyr.

### 5.—*Ventilation.*

1. Which is, theoretically, the best form of air-way underground? Illustrate by sketches.
2. The velocity in a main air-way is 890 feet per minute. The water-gauge is ·5 inch. If the velocity is increased to 1,000 feet per minute, what will be the water-gauge? Will it increase or decrease? By how much, and why?
3. Which is practically the best, a large number of small air-ways or a fewer number of large air-ways?

4. A circular arch is 14 feet diameter and 143 yards long. (*a*) Describe with sketches how you would proceed to measure the velocity of the air. (*b*) If the velocity was 782 feet per minute, what was the quantity passing?

### 6.—*Coal Mines Act.*

1. What does the Act, Sec. 16 (1) (*a*) (*b*) (*c*) say with regard to single shafts? What, in your opinion, are the reasons for these provisions?
2. What does the Act provide with regard to ventilation?
3. What does the Act require with regard to—
   (*a*) Places where safety-lamps are required?
   (*b*) Timbering?
   (*c*) Examination of lamps?
   (*d*) Brake and indicator?
4. What does the Act state with regard to firemen's inspections before and during shifts?
5. What is your opinion of the difference between the 1887 and 1896 Acts with regard to firemen's inspections?

### 7.—*Surveying.*

1. A survey was made with the magnetic needle in 1818 when the variation was 20° 41′ west. A re-survey was made in 1902, but without allowing for difference in magnetic variation.
   (1) S 74° E, 211 links.
   (2) N 80° E, 480 links.
   (3) N 17° E, 700 links.
   (4) S 45° E, 832 links.
   (5) S 37° E, 1,134 links to face.
   What is the distance from the actual to the assumed positions of face, and what is the bearing?
2. What are traverse tables? Explain their use by giving an example.
3. In chaining down a declivity drift with a dip of 20 inches per yard, what precautions would you take to ensure accurate measurements?
4. Explain, by plotting on a scale of two chains to an inch, how you would deal with bearings taken on varying gradients as follows:

| | *Links.* | *Declivities.* |
|---|---|---|
| N 50°W .... | 173 .... | 6°15 |
| N 17°E .... | 210 .... | 10°30 |
| S 30°E .... | 317 .... | 17°30 |
| S 10°E .... | 420 .... | 26°30 |

(There may be a slight error in some of these figures.)

## Cardiff (1st Class), 1902.

### *Machinery.*

1. A haulage road is 376 yards long, dipping 12 inches per yard, and it is required to haul up 500 tons per day of 9 hours, less 1 hour for meals. Capacity of trams = 20 cwt. Give size of pair of engines to do the work, and find size of rope, couplings, &c. Steam pressure of 100 lb. available.
2. What is the use of a water-gauge as applied to a Lancashire boiler?

   Describe with a sketch the principle on which it acts, and explain how it may become unreliable in use.
3. Give a dimensioned sketch of a sinking bowk to raise 18 cwt. of rubbish from a shaft which is being sunk to a coal seam; drawing to be on a scale of 1 inch = 1 foot.

   Give a separate sketch of the detaching hook with dimensions.
4. A shaft is 160 yards deep, and from the bottom a slant is driven for 750 yards, and dipping 1 in 2. There is a feeder of 200 gallons per minute at end of slant and a similar feeder at pit bottom. Give particulars of pumping plant to clear the water in one shift. Steam pressure of 100 lb. available at surface.

### *Geology.*

1. What is pyrites? Where is it found, and what are its characteristics?
2. How are the coal seams of South Wales grouped? Give divisions with distinguishing features of strata.
3. Where are the positions of Old Red Sandstone and New Red Sandstone with regard to Carboniferous Formation?
4. What are the fossils of the South Wales Coal Measures?

### *Coal Mines Regulation Act.*

1. Give General Rules relating to—(*a*) manholes, (*b*) lamp stations, (*c*) inspection by workmen.
2. Under what conditions may detonators be used underground?
3. Give list of books required by C.M.R.A., and write short descriptions of each.
4. Give the Special Rules in your district with regard to (*a*) weighers, (*b*) stokers, (*c*) ventilating enginemen.

*Ventilation.*

1. A semi-circular air-way is 10 feet high and 10 feet wide. Velocity of air is 5 feet per second. Explain in detail—
   (*a*) How you would measure the air current;
   (*b*) How often the current must be measured to comply with the C.M.R. Act.
2. How would you set about restoring the ventilation in a mine where an explosion of fire-damp or coal-dust has occurred? The doors and air crossings are destroyed, but the fan is intact.
   What precautions would you take in order to secure the safety of the workmen?
3. How would you ventilate a shaft 450 yards deep sunk through the coal measures?
4. Ventilate plan.

*Surveying.*

1. A square inch on a plan represents 17·7 acres. What is the scale in chains to an inch? A plan is drawn to a scale of $\frac{1}{2500}$; what acreage does a square inch represent?
2. Describe shortly how you would make an underground survey with the theodolite.
3. Work out following levels — — and find gradient.
4. How would you set out a curve of 10 chains radius with chain and poles only?

*Arithmetic.*

1. Find the area of triangular field whose sides are 560 links, 950 links, and 780 links.
2. What is the diameter of circular shaft which is equal to an oblong one 13 feet 6 inches by 9 feet 6 inches?
3. A shaft is 20 feet diameter and 215 fathoms deep. What is the weight of material excavated?
   1 cubic foot = 148 lb.
4. A taking has an area of 497 acres. The seam is 4 feet 5 inches thick, S.G. = 1·29. How many tons of coal are there in the taking?

*Practical Working.*

1. There are two main roadways, one dipping 17 inches per yard and the other 2 inches per yard. Gauge of road 2 feet 8 inches. Give cross and longitudinal sections of each roadway on a scale of $\frac{1}{2}$ inch per foot. Longitudinal sketches to show a length of at least 8 yards and to include at least 4 pairs of timbers. Roof and side pressure in first roadway; roof pressure only in second.

2. A fault is met with at a distance of 1,432 yards from pit bottom in a mine which is dry and dusty. How would you ventilate the drivage and make the place safe for shot firing ?
3. Give sketch plans and sections showing the working face in a seam known to you—
   (*a*) Where the face is well timbered ;
   (*b*) Showing the same face improperly timbered ; and show in the latter case how an accident may occur.

---

Cardiff (First Class), 1901.

*Mines Act.*

1. In opening a new mine what precautions would you take to comply with the Act ?
2. A fatal injury happens to one of your workmen. What steps would you take in accordance with the Mines Act ?
3. What do the Special Rules of this district say in regard to—
   (*a*) Manholes ;
   (*b*) Hitchers ;
   (*c*) Enginemen ?
4. A manager placed temporarily his lamp-station in part of his main return. Did he commit a breach of the Act ? And why ? State the rule referring to this.

*Arithmetic.*

1. A collier earns by cutting 22 tons of coal £2 15s. when wages are 15 per cent. above the standard cutting price. What is the standard cutting price ?
2. There are three properties of the following acreage :—
   (1) 3 acres 2 roods 20 perches, and underlying this there is a seam 3 feet 6 inches thick.
   (2) 2 acres 1 rood and a seam 5 feet thick.
   (3) 3 acres 1 rood, and seam 4 feet 3 inches thick.
   Specific gravity of coal in each case 1·25.
   35 per cent. of the total quantity of coal is lost.
   What quantity is brought to bank ?
3. No. 1 Property, output 800 imperial tons of which 15 per cent. is small, the royalty on large coal is 7d. per ton, and on small 3d.

No. 2 Property, output 600 tons, of 2,520 lb. to the ton, 15 per cent. of which is small, royalty large 7d. per ton, and small 3½d.

No. 3 Property, 1,000 tons through coal of 2,400 lb. to the ton, royalty 6½d. per ton.

What are the royalties paid by the colliery, and the average per imperial ton?

4. Find the value of—

$$\sqrt{\frac{\frac{2}{3} \times \frac{3}{4}}{\frac{1}{2} + \frac{1}{3}}}$$

*Ventilation.*

1. Sketch and describe the water-gauge as used in mines.
2. The quantity of air passing in a mine is 120,000 cubic feet per minute, with a water-gauge of 1·25. What is the horse-power of ventilation?
3. What are air-crossings for? Sketch one, showing construction, and how it saves the use of doors.
4. A seam dips 12 inches per yard. Show how you would open out workings all to the deep of the two pits sunk, and show how you would ventilate same.
5. On what fan has there been an improvement by opening out the ends? Sketch same, and state the effect of the improvement.
6. What advantages do you get from splitting the air? To what extent can this be done, and why?

*Geology.*

1. Strata of ground show the angle of dip as 20 degrees, the strike of strata N 20 E, direction of dip S 30 W. The following ground was sunk through:—

| | *Yds.* | *ft.* | *in.* |
|---|---|---|---|
| Soil .. .. .. .. | – | 2 | 6 |
| River sand .. .. .. | 1 | 1 | 3 |
| Blue clay .. .. .. | 6 | 2 | 4 |
| Argillaceous shale .. .. | 10 | 1 | 6 |
| Sandstone .. .. .. | 33 | – | 2 |
| Grey sandstone .. .. .. | 15 | – | – |
| Arenaceous shale .. .. | 9 | 2 | 10 |
| Grey sandstone .. .. .. | 22 | 1 | 4 |
| Argillaceous shale .. .. | 7 | 2 | 9 |
| Sandstone .. .. .. | 8 | 0 | 0 |
| Coal .. .. .. .. | 1 | 1 | 3 |

Plot a vertical section of this shaft to a scale of 20 yards to one inch.

2. What is :— (1) Argillaceous shale ?
   (2) Arenaceous shale ?
   (3) Fire-clay ?
   (4) Grey sandstone ?
   (5) Strike of strata ?
   (6) Angle of dip ?
3. Draw a section, scale 1 foot to 1 inch, of a seam of coal in work ng which you have had experience.

*Machinery.*

1. A pit 250 yards deep is full of water. At 100 yards in depth there are old workings full of water to the dip, 100 feet below the level in the shaft, there is another seam at the 250 yards.

   At the 100 yards there is known to be a feeder of water of 500 gallons per minute, also in the old workings at this point another feeder of 100 gallons per minute.

   How would you proceed to clear the pit of water, and show what kind of pumps, &c., you would fix to deal with this water ?
2. Sketch a double-decked cage, and show how trams are secured.
3. What is Richard's indicator ? Describe and sketch same.
4. Sketch a Lancashire boiler, 30 feet by 8 feet for pressure of steam of 120 lb., and show fittings.

*Surveying.*

1. Describe the method of fast needle surveying, and say when you would adopt it.
2. What is Gunter's chain ? Describe it. What is the length of a link ?
3. A trapezium is as follows :—Its diagonal 850 links ; one vertical 240 links ; and the other 225 links ; what is its area ? Also plot same to scale of 2 chains to one inch.
4. What adjustments do you make in a level ? How would you discover parallax when levelling ?

*Practical Working.*

1. A seam of coal 5 feet 6 inches is of full section.

| | *ft.* | *in.* |
|---|---|---|
| Weak shale roof. | | |
| Top coal .. .. .. .. | 1 | 4 |
| Clod .. .. .. .. .. | 0 | 10 |
| Bottom coal .. .. .. .. | 3 | 2 |
| Holing .. .. .. .. | 0 | 2 |
| | 5 | 6 |

Dip 1 in 18, and is worked by the Nottingham system. Sketch plan, to a scale of 1 chain to 1 inch, showing a district opened to produce 200 tons per day.

2. What is meant by systematic timbering? What is it that is hoped to be gained by its adoption?
3. What are the principles that would guide you in standing a pair of double timber? Show by a diagram to scale of 1 inch to 1 foot a pair of double timber in a heading whose sectional area is 10 feet 6 inches (at bottom) by 7 feet 0 inches high in the clear.
4. A seam is 4 feet thick dipping 1 in 12, and worked by long wall system. In one side of the workings, and at 1,200 yards from the pit, a fault occurs throwing the seam upwards a vertical height of 32 yards, and cutting off 400 acres in about equal quantities to the rise and dip of the pits.
   (*a*) How would you work the coal beyond the fault?
   (*b*) Give a section to the scale of one chain to one inch, showing the openings you would make through the fault.

---

## CARDIFF (1ST CLASS), 1899.

### *Mines Act.*

1. What are the provisions of the Act with regard to manholes, signalling, shot-firing, and duties of fireman?
2. Under what conditions is it necessary to withdraw workmen from a mine? Also give the General Rule upon the subject.
3. What are the provisions of the Act with regard to inspection on behalf of workmen? Also quote the General Rule upon the subject.
4. What do the Special Rules of your district specify with regard to the duties of firemen, banksmen, and hauliers?

### *Ventilation.*

1. The power expended on the ventilation of a colliery is 56·126 H.P. The W.G. is 3·75. What is the quantity of air passing per minute? If the W.G. was 1·75, what would then be the quantity passing?
2. An old colliery is required to be re-opened, and the shafts are 1¾ miles apart, with extensive workings opening out from them. A ventilating fan has been erected at the top of the upcast shaft. The shafts and workings are

full of gas, from the top of the downcast to the top of the upcast. How would you clear the gas? Shafts 300 yards deep.

3. In a colliery with an output of 600 tons per day of nine hours, there are two ventilating districts with a day and night fireman in each. Describe in detail the duties of both day and night fireman respectively.
4. Under what conditions does a Davy and Clanny lamp become unsafe? Why is it necessary to shield the gauze? What safety-lamp would you recommend for use in a fiery mine? Give your reasons for the same.

*Geology.*

1. Define the following, and where possible, illustrate by a sketch :—

   Fossil, unconformable, overlap, Lade, fault, anticline, syncline, denudation, Dyke.
2. Sketch and enumerate the fossils found in the Coal Measures above the Mountain Limestone.
3. What are the component parts of a coal seam? Show how these vary in different coals; show how the various districts throughout South Wales are affected by the change, and name the different districts with the composition of the coal in each.
4. Draw a sketch both in plan and section of the district for a radius of 10 miles around the place where you reside, showing the principal faults, also the direction and rate of dip of the strata, and if pits were sunk within that radius name the seams of coal likely to be met with in the different localities, to a depth of 500 yards.

*Engineering.*

1. Sketch and describe a Lancashire boiler, showing the connections of the end plates and construction of the furnace, flues, and show position, extent, and dimensions of firegrate. Enumerate the principal fittings, and show in your sketch, also give cross section showing position of bottom and side flues respectively.
2. It is required to erect a pair of engines to work an underground plane 1,500 yards long by main and tail, with a gradient of 1 in 80 in favour of the load. Motive power compressed air 50 lb. per square inch. Output 400 tons in 9 hours. Give dimensions of engines, size of cylinder, length of and number of strokes per minute, diameter of drum, size of ropes, &c. Show by sketches the size of rollers and sheaves you would use, and where placed,

also mode of carrying the side rope, with particulars of how the supports of the rope are secured to the side of the plane. Sketch the two double partings, showing the position of the return sheave, and how fixed, also show position of hauling engine.

3. A hemp rope, $1\frac{3}{4}$ inches diameter, exerts a pull equal to 12·16 h.p. per 1,000 feet travelled per minute, and is used for driving a fan. Fan gives 120,000 cubic feet of air at $2\frac{3}{4}$ inches W.G. Calculate the number of ropes necessary to drive the above, the engine making 43 revolutions per minute, and the diameter of the driving pulley being 17 feet 6 inches.
4. In a fiery mine a heading 700 yards long dips 4 inches in the yard. At the bottom of this heading a spring is tapped, giving 120 gallons per minute. Give an account of how you would deal with this emergency, giving details of the dimensions of pump you would adopt, and also your motive power, and give your reasons for the adoption of such method and such dimensions.
5. Give an account of the shaft equipments requisite for a pit raising 1,200 tons in 9 hours from a depth of 500 yards. Give particulars of the dimensions of cages, ropes, guides, and fangs.

*Practical Working.*

1. A seam is of the following section :—

| | *ft.* | *in.* |
|---|---|---|
| Coal .. .. .. .. .. | 2 | 9 |
| Clod .. .. .. .. .. | 1 | 3 |
| Coal .. .. .. .. .. | 2 | 3 |
| Fireclay .. .. .. .. | 0 | 9 |
| | 7 | 0 |

Roof. Very strong clift.

Describe and show by sketches how you would open out and work the above seam by the Nottingham or Barry system, giving particulars as to the distance between cogs where required, and distances you would carry your roads as well as their distance from one another. Also distance between props, sprags, and trams.

2. Under what conditions may long wall, pillar and stall, and Nottingham systems be adopted ? Give the advantages and disadvantages of each, and show the adaptation of either to the working of a seam of coal 6 feet thick with rather weak roof.

3. A seam of coal, 4 feet thick, dipping 1 in 2, is to be worked by means of a slant driven from the surface. The seam is very fiery, and the intended output is 600 tons per day. Describe and show by sketches how you would arrange your workings for the above output. Show in your plans the main haulage roads and courses of ventilation. Also give enlarged view of two working places, showing how the coal is worked, the air coursed, and how the rubbish is got to the working face, and effectually stowed.
4. Describe in detail and show by sketches the operations of sinking, laying a curb, and walling a large pit, 18 feet in diameter.
5. State what you know about the use of high explosives, and state why it is absolutely necessary that they should be used in mines. Give the composition and peculiarity of a few of the high explosives.

*Surveying.*

1. The following are the bookings of a survey taken along a road between two shafts A and B. Shafts are on same surface level.

   Centre of pit.—A.

   (1) N 49° W .. (729) .. Acclivity 26° 30′
   (2) N 46° W .. (454) .. „ 15° 45′
   (3) N 17° E .. (424) .. Level.
   (4) N 74° E .. (538) .. Declivity 19° 45′

   Centre of Pit.—B.

   Plot the above in plan and section to a scale of two chains to an inch. (Pit A being 270 yards deep.)
2. It is required to drive a drift from the bottom of Pit A to the bottom of Pit B. By means of data obtained from the preceding question make out:
   (*a*) Its direction;
   (*b*) Its length;
   (*c*) Its rate of dip;
   (*d*) Depth of Pit B.

*Arithmetic.*

1. If the money due to 50 men for 12 months is £1,080, what sum will be due to 36 men for 7 months?
2. (*a*) Reduce $\frac{3}{32}$ and $4\frac{3}{14}$ to decimals.
   (*b*) Express $\cdot 0\dot{1}2\dot{3}$ as a vulgar fraction.
   (*c*) Divide ·01 by ·0001.

3. A plot of land intended for a garden has its two parallel sides 59 feet 6 inches and 49 feet 7 inches long respectively, and the perpendicular distance between them is 54 feet 9 inches. If this land cost £325 10s. per acre, what is the value of this piece ?
4. How many yards of paper will be required to paper a room $20\frac{5}{8}$ feet long, $11\frac{1}{3}$ feet wide, and $12\frac{7}{10}$ feet high, the paper being $\frac{5}{8}$ of a yard wide, and what will it cost at $2\frac{1}{4}$d. per yard ?
5. A cistern has three pipes connected to it. The first pipe will fill the cistern by itself in 40 minutes, the second will fill it alone in 50 minutes, while the third will empty it in 25 minutes. If all three pipes were opened together, in what time would the cistern be filled ?

---

## CARDIFF (1ST CLASS), 1898.

### *Ventilation.*

1. From what does ventilation arise ? Describe the different methods of producing it.
2. What is fire-damp ? Describe the gases met with after an explosion.
3. If in an air-way 1,000 yards long, 9 feet wide, and 6 feet high, 6,000 cubic feet of air pass per minute, what is the pressure per square foot if co-efficient of friction is taken at ·0028 ?
4. Describe the use of air-bridges. State advantages and disadvantages of each kind.
5. If 20,000 cubic feet pass an air-way with 2 inches W.G., what is the additional H.P. for 60,000 ?
   Plan given to ventilate.

### *Arithmetic.*

1. Multiply 144 by the cube root of 57.
2. If a plan is drawn to a scale of $\frac{1}{2700}$, how many chains will be represented by an inch ?
3. Three royalties, A, B, C. The royalty paid on large coal from A is 9d., and on small coal $4\frac{1}{2}$d. per ton. B, large 7d., and small 3d. per ton. C, large 9d., and small 3d. per ton. The percentage of small coal in A is 30 per cent.; in B 23 per cent.; and in C 20 per cent. The total royalty paid on A was £640; B, £500; and on C £320.

A ton in A royalty = 2,280 lb.
" B " = 2,250 "
" C " = 2,240 "

How many imperial tons were got from each royalty?

4. Two men and a boy worked together in a face, and were paid for—

| | s. | d. |
|---|---|---|
| 90 tons of coal .. .. .. | 1 | 4½ per ton. |
| 7 pairs timber .. .. .. | 1 | 6 per pair. |
| 13 yards cutting bottom at .. | 0 | 4½ per yard. |

How much did each get if the boy C got ½ of what B got, and B got ⅔ of what A obtained?

*Coal Mines Act.*

1. A manager gives orders to rip down a piece on a main haulage road with the use of a high explosive. State how he may do so without contravention of the Act.
2. What are the requirements of the Act as to ventilation?
3. What are the rules as to—
   (*a*) Use of safety-lamps?
   (*b*) Construction of safety-lamps?
   (*c*) Examination of safety-lamps?
   (*d*) Provision of a lamp station?
4. What privileges are given to the colliery workmen for inspection of workings? State the rules.

*Geology.*

1. What is— Carbonaceous shale
   Arenaceous "
   Argillaceous "
   Sandstone?
2. Give a section of the pit best known to you.
3. If there was a seam of coal lying at an angle of 26° 30′, and intersected by a cross measure heading, describe how you would measure the strata for a vertical distance of 20 feet above the seam and 20 feet below. (The section of strata above and below for 20 feet was given.)
   Describe the answer with large size sketch.
4. Show on a sketch map of the South Wales coal-field, the areas where anthracite and bituminous coal are found.

*Practical Working.*

1. What are the conditions best suited to the working of a seam of coal 6 feet thick, very gaseous, by the double road stall system
2. What precautions would you adopt for the safety of the sinkers in sinking a pit 600 yards deep, 18 feet diameter?

3. Describe with sketch the opening out of your workings for an output of 400 tons from a seam of 4 feet thick, lying at an inclination of 18 inches per yard. Gas given off very freely, little water, good rock roof; workings on pillar and stall method. Show ventilation on sketch.
4. At a colliery the output is 1,000 tons per day. It is required to increase it to 1800 tons per day, as quickly as possible. State how you would do so, and what you would do to provide for the safety of the men.

*Machinery.*

1. State the principle of the hydraulic pump. What are its advantages and disadvantages?
2. Describe the operation of putting a winding rope upon a drum, and what would you especially guard against?
3. Problem given to work out size of hauling engine.
4. Describe the use of Richard's indicator, and show on a hypothetical diagram the effects of wire drawn steam, back pressure and expansion, and state how you would obtain the average steam pressure on the piston in a cylinder.
5. What are some of the common causes of boiler explosions, and how would you guard against them?

*Surveying.*

1. Describe surveying with fast and loose needle, and what errors would you guard against?
2. Reduce the following levels:—

| *Back.* | *Fore.* | *Rise.* | *Fall.* | *Reduced Level.* |
|---|---|---|---|---|
| 8·20 | 3·01 | | | |
| 4·25 | 4·24 | | | |
| 0·19 | 9·97 | [These figures are only approximate.] | | |
| 3·62 | 7·77 | | | |
| 5·90 | 4·01 | | | |

3. Plot the following bearings:—

| | | |
|---|---|---|
| N 20° 15′ E .. | 484 links | [These are the actual bearings and distances as set in the Question.] |
| N 74° 30′ W .. | 372 „ | |
| S 48° 00′ W .. | 828 „ | |
| S 2° 00′ E .. | 200 „ | |

What is the length of the line and bearing of same from starting to finishing point?

4. What is meant by magnetic declination, and how is it allowed for on plans?
5. In a level half a mile long and 9 feet wide, in a 4 feet 3 inches seam of coal, how much coal would be got? S.G., 1·25. Loss 30 per cent.

### Cardiff (1st Class), 1897.

*Practical Working.*

1. Show on plan how you would open out a seam 4 feet 6 inches thick (lying at an inclination of 1 in 12) to produce 800 tons per day, shafts 18 feet diameter, but one used as air shaft.
2. Denote position of hauling engines for above; also ventilation crossings, &c. Depth of shaft 400 yards.
3. State the size of shaft pillar that you would adopt and the pit bottom arrangements; also
4. The number of men employed and the length of face opened out.

*Machinery.*

1. Describe a good form of steam pipe joint, and an expansion joint for a 9-inch pipe (diameter).
2. Describe with sketches the position of head gear, drum, brake, and brake gear. State the precautions you would adopt to prevent accidents when winding.
3. The breaking strain of a winding rope is 42 tons; what would you adopt as its safe working load? When and how would you examine such ropes? How would you keep a record of such, and what records are necessary? How would you examine a flat rope? State what records are necessary.
4. Describe and illustrate with sketches an ordinary Lancashire boiler, 30 feet long and 8 feet diameter, working at 100 lb. pressure. Describe with diagrams such fittings as are necessary; under what conditions would you consider it unsafe to work such a boiler?
5. A shaft 534 yards deep has at its bottom a spring of water making 150 gallons per minute, and a heading dipping 1 in 12, making 64 gallons per minute. What arrangements would you adopt above and below ground?

*Coal Mines Act.*

1. What are the regulations regarding the employment of boys, girls, and women?
2. What is the abstract of the Act, and what are the rules regarding the abstract and Special Rules?
3. What are the rules relating to shafts and to winding through them?
4. What are the "Special Rules" relating to hauliers?
5. What are the Special Rules relating to banksmen and *hitchers*?

*South Wales Coal-field.*

1. Describe briefly the South Wales coal-field, and draw a plan of the same.
2. Name the main faults, give their direction, and amount of vertical throw.
3. What is anthracite, steam, and bituminous coal? Give an analysis of same.
4. Define meaning of following terms:—Laminated, Fault, Overlap, Nip, Washout, Leadings, Unconformable, Synclinal.
5. Draw a section through the coal-field showing the distance between the seams, and give a section of some of the seams.

*Surveying.*

1. How would you make a fast needle survey, and how would you make a loose needle survey?
2. There are two seams of coal dipping 3 inches in a yard, and the horizontal tunnel driven from lower to upper level course is 160 yards. At a point 30 yards above is an accumulation of water. What would be the length of roadway driven from lower to upper seam to tap this water, and what is its inclination per yard?
3. Describe levelling and give an example of same.
4. What precautions would you take when surveying with the "magnetic needle"?

*Ventilation.*

1. What is the composition of after-damp? What are the properties of the resultant gases?
2. What is the theory of ventilation? What do you mean by "splitting" the air, and how does it affect the ventilation?
3. Describe and sketch a good form of safety-lamp suitable for a fiery mine with a high velocity.
4. Describe the barometer, thermometer, anemometer, and water-gauge, and their uses in mining.
5. Two air-ways 2 miles long—the first is a square one, its side is 7·091 feet high and the end is 10 feet wide and 5 feet high. Find pressure required to force 20,000 cubic feet through each, taking co-efficient of friction as ·009.

*Arithmetic.*

1. The average earnings for a man and boy was £10 7s. 11d., that being as standard earnings. During the next year

they earn £14 19s. 1d. per month, and 3rd year £17 19s. 11d. per month. What is the increase in percentages ?

2. A Lancashire boiler, 30 feet long, 8 feet diameter, contains two tubes, each 2 feet 10 inches diameter ; in each tube there are two cross tubes 9 inches diameter. Find the weight of water the boiler will hold.
3. There were 189,000,000 tons of coal raised in 1895, of which 67 per cent. was large, the remainder 33 per cent. small. If the royalty was on the large 7d. per ton, and small 3½d., what was the total royalty ?
4. Find $2\frac{3}{4}$ of $\frac{7}{22}$ of 5 acres.
5. If 1 ton of material cost £3 14s. 7d., how much would 14 tons 3 cwt. 9 lb. cost ?
6. The area of a shaft is 259·279 square feet ; find its diameter, and circumference.

---

### Cardiff (2nd Class), 1898.

*Arithmetic.*

1. A tank 8 feet long by 4 feet wide, and 2 feet deep, open at the top, has been built with $\frac{3}{4}$ inch iron plate. If a square foot 1 inch thick of the iron weighs 45 lb., what is the weight of the tank, allowing 8 per cent. for flanges ?
2. An air-way is 9 feet 3 inches wide in the top, 12 feet 6 inches wide in the bottom, and 7 feet 4 inches high from sleepers. If there are five readings of anemometer which equal 681·6 feet velocity, find the quantity of air passing.
3. The standard price for cutting a seam of coal is 1s. 7½d. per ton, on which is added $43\frac{3}{4}$ per cent. What is the cutting price ?

*Mines Act.*

1. Quotes the rules and Act :—
   (*a*) As to fatal accidents ;
   (*b*) Safety-lamps ;
   (*c*) Banksman ;
   (*d*) Hitcher ;
   (*e*) Hauliers ;
   (*f*) The person who is in charge of the mine when the manager of the mine is absent.

*Working Coal.*

1. Describe the long wall and pillar and stall systems of working. Also state which you prefer, and why.
2. Describe the best methods you know for drawing water from a dip.

3. Describe how you would secure a circular shaft 15 feet diameter for setting masonry.
4. Describe the best guides you are acquainted with.
5. Describe and sketch how you would erect a dam for 300 feet head of water in a heading 5 feet 6 inches high and 6 feet wide in coal.

*Ventilation.*

1. Describe with sketch the safety-lamp you would adopt in a fiery steam coal colliery, and by whom, when, and where you would have the lamps examined and locked.
2. Explain the principle of the water-gauge.
3. Describe the air-crossing you would make for a current of 25,000 cubic feet of air per minute in a steam coal colliery in which there was no seam being worked. Also state the velocity of air passing through the air-crossing.
4. Describe shortly the Waddle fan.
5. A fall occurs on a heading within 100 yards of the coal face liberating a large quantity of gas; the fall is 5 yards long and 15 feet high from rail to the top of the cavity which is full of gas; describe fully how you would clear the gas.

---

CARDIFF (2ND CLASS), 1897.

*Arithmetic.*

1. A return air-way is 7 feet 4 inches wide at the top, 10 feet 10 inches wide at the bottom, height from rail being 7 feet 4 inches. What is the sectional area?
2. The anemometer shows 693 revolutions, and area of heading 63·5 feet. What is the quantity of air passing?
3. What percentage is $11\frac{1}{4}$ on £6 17s. 10d.?
4. Multiply £3,724 10s. 7d. by 197.
5. The annual output of a colliery is 107,467 tons, 13 cwt., but only 217 days are worked. What is the average output per day?

"*Mines Act.*"

1. What does the Coal Mines Regulation Act state about second outlets? Name the section.
2. How would you proceed and what precautions would you take in driving towards old workings? Give your reasons.
3. What are the duties of an under-manager?

4. If a manager in case of an accident at the mine does not report it to the Inspector of Mines, what penalty is he liable to ?
5. Under what conditions would you withdraw the workmen from a mine ? State the section of Act.

*Method of Working.*

1. Show how you would timber a main level with—
   (*a*) Weak roof, strong sides and floor ;
   (*b*) Weak roof, strong sides, and weak floor ;
   (*c*) Strong roof, weak sides and floor.
2. Under what conditions would you adopt long wall and single road system of working ? Give sketches.
3. If you were called to examine a colliery, what are the chief points which would draw your attention ?
4. How would you work a 5-foot seam, dipping 1 in 3, with little materials for packing, and how would you timber it ? Give a sketch.

*Practical Ventilation.*

1. Describe and illustrate the barometer, anemometer, and thermometer, and give their uses for mining purposes.
2. What is meant by air-splitting ? Give the advantages and disadvantages.
3. Describe and illustrate the various methods of air-crossing in South Wales.
4. Describe briefly the various methods for producing ventilation.
5. A door is 6 feet high, 7 feet wide, and the water-gauge on it shows $3\frac{3}{10}$ inches. What is the total pressure on the door ?

---

Cardiff (2nd Class), 1896.

*Arithmetic.*

1. Multiply ·47 by ·0008. What is ·785 of £1 ?
2. If 138 gallons of oil cost £65 11s. what would 475 gallons cost ?
3. If 12,615 tons 18 cwt. of large coal are raised at a colliery and 2,994 tons 2 cwt. of small coal, what is the percentage of small to the gross output ?
4. A pit is 10 feet diameter and 30 feet deep. How many gallons of water will it hold ?

*Practical Working.*

1. What precautions would you take to ensure the greatest amount of safety in—
   (*a*) Long wall working ;
   (*b*) Pillar and stall ?
2. Describe the methods of timbering adopted in your colliery. Show how you would timber up a "running" fall.
3. A trial shaft is to be sunk 7 feet diameter, 30 yards deep, with shaly ground, and 28 feet of sand soil. How would you proceed ? Describe the appliances you would use.
4. Under what conditions is long wall preferable to pillar and stall ?
   Sketch a long wall district dipping 2 inches in the yard, and pillar and stall dipping 20 inches per yard.

*Ventilation.*

1. What do you know of fire-damp ? How does it differ from black-damp ?
2. If 30,000 cubic feet of air pass through an air-way 8 feet by 6 feet, what is the velocity in feet per second ?
3. In making an examination of a long wall face you find three stalls near the centre of your workings full of gas ; how would you proceed to remove it ?
4. If your water-gauge on a mine ventilation door suddenly rose or fell, how would you proceed to ascertain the cause ?
5. Give a diagram showing the district in which you are employed, showing brattice doors, course of ventilation, &c.

*Coal Mines Act.*

1. State the rules applying to the employment of boys underground and on the surface.
2. What are the provisions of the rule as to the inspection by workmen ?
3. State the rule about stations, and of the periodical inspections as to the condition of the mine.
4. What are the Special Rules in your district as to colliers, banksmen, and winding enginemen ?
5. State the rule as to giving notice in case of accidents.

---

CARDIFF (2ND CLASS), 1895.

*Arithmetic.*

1. Work the following:—7,854 × ·003 × $\frac{2}{5}$ ÷ ·33.

2. A cylinder has a circumference of 3 feet 6 inches, and is 6 feet deep. How many gallons of water will it hold?
3. Find the money due for 57 tons 4 cwt., at 1s. 7½d. per ton, 16 yards 2 feet of top rippings at 8½d. per yard; add advance of 21¼ per cent.
4. A heading 1,200 yards long falls 250 feet 6 inches. What is the dip per horizontal yard, and what is the gradient?

*Modes of Working.*

1. Name the colliery you work at; describe the modes of working and systems of haulage. Sketch and describe some district you are acquainted with, showing direction of air-currents, position of doors and stoppings.
2. A pair of pits have been sunk to a seam of steam coal 500 yards deep, thickness of seam 6 feet, a good clift roof. Describe and sketch fully how you would lay out your workings to raise 1,000 tons per day. Dip of seam 1 in 12.
3. Describe and sketch—
   An upthrow fault;
   A downthrow fault;
   A roll;
   An overlap;
   A washout.
4. A stall is cut off by a cross-heading. State how you would proceed to stow the same.
5. If you were called on to make a thorough examination of a colliery, how would you proceed? State briefly the chief points to which you would direct your attention.

*Ventilation.*

1. An air-way is 176 yards long. It is 7 feet 6 inches wide, 6 feet to the spring of the arch, then radius of arch is 3 feet 9 inches, velocity of air shown by anemometer 574 feet. What is the quantity passing per minute?
2. What is a water-gauge? Describe its uses.
3. What are the indications of gas in a non-fiery mine with a weak ventilation? Also indications in a fiery mine, of insufficient air supply?
4. An air-way is 9 feet by 6 feet 6 inches. Another is 10 feet 6 inches by 4 feet 9 inches, and the same quantity of air passes in both air-ways. Which shows the highest velocity? Why?
5. Describe under what circumstances an ordinary Clanny lamp becomes unsafe.

*Mines Act.*

1. What are the provisions regarding use of explosives ?
2. What are the provisions regarding driving towards old workings ?
3. What does the Act say with regard to sizes of roads and also what rules refer to timbering ?
4. What provisions are there for workmen's inspections ?
5. State Special Rules with regard to hauliers.

---

CARDIFF (SECOND CLASS), 1894.

*Arithmetic.*

1. How many feet are there in 13 chains and 73 links ?
2. 7854 × 4587 × 5487 × $\frac{1}{3}$ and 78·54 × 45·87 × 6·834 × ·33.
3. Two men drive a hard heading 4 yards 1 foot at 37s. 6d. per yard + 12½ per cent. How much are their total earnings ?
4. A collier cuts 4 tons 12 cwt. at 1s. 1½d. + 11¼ per cent. per day. What were his total earnings for 25 days ?
5. What is the area of a circle whose diameter is 9 inches ?
6. How much is 7 feet 4½ inches × 13 feet 10 inches × 74 yards, also 13 feet 10 inches × 8 feet × 5 feet 6½ inches ?

*Ventilation.*

7. Describe the various methods used for the production of ventilation in mines. Discuss the advantages and disadvantages of each of them.
8. What are the gases found in mines, and where are they to be found ?
9. State the advantages and disadvantages of splitting air underground.
10. Which shows the highest water-gauge, 80,000 cubic feet of air passing through an air-way 8 feet by 5 feet, or 40,000 cubic feet of air passing through an air-way 4 feet by 5 feet ? Give reasons for your answer.

*Mines Act.*

11. What does the Act specify as to——
    (*a*) Boilers ; (*b*) Breaks ; (*c*) Barometer ?
12. State the 38th General Rule.
13. What do the Special Rules say with regard to hauliers ?
14. What do the Special Rules say as to naked lights and safety-lamps ?
15. What does the Coal Mines Regulation Act state as regards giving notice of accidents in the mine ?

16. What does the Act specify as to the duties of an under-manager ?

*Practical Working.*

17. What arrangements would you make in a mine giving off gas, where explosives are used ?
18. In approaching old workings containing water, what precautions would you take ?
19. Sketch the last district you were employed in, showing ventilation, doors, brattices, &c.
20. In visiting a collier's stall, what points would take your attention ?
21. Describe the following methods of working—
    (*a*) Long wall ;
    (*b*) Single road stall;
    (*c*) Double road stall.

---

Cardiff (2nd Class), 1893.

*Arithmetic.*

1. An air-way is 56 yards long, 5 feet 3 inches by 8 feet 6 inches. How much air will it contain ?
2. A cylinder is 7 feet long and 6 feet in diameter. How many gallons of water will it hold ?
3. Work out the following :—
   6 yards 2 feet at 1s. 3d. per yard.
   48 tons 16 cwts. at 1s. 8½d. per ton.
   5 pairs timber at 10¾d. per pair.
4. ·07504 ÷ 23·43.

   Reduce to a decimal $\frac{47\frac{5}{8}}{94} \times \frac{11\frac{3}{4}}{7\frac{1}{2}}$
5. A heading which is 1,304 yards long rises 380 feet 4 inches in this total length. Find the average rise per yard.

*Ventilation.*

6. Describe the water-gauge. What is the pressure per square foot when the water-gauge is 1 inch ?
7. Describe the safety-lamp in use at your colliery.
8. There are two parallel air-ways in which 20,000 cubic feet of air is passing. They are 1,000 feet long, 4 feet high, and 6 feet wide. Substituting one air-way of the same length, 8 feet high by 8 feet wide, what, if any, is the difference in the quantity of air passing ?
9. Describe how you would proceed in search of fire-damp, and what precautions you would take to remove it.

*Mines Act.*

10. What does the Act state as to—
    (*a*) Inspection on behalf of workmen ;
    (*b*) Employment of boys underground ;
    (*c*) Manholes ;
    (*d*) Inspection of machinery and shafts ;
    (*e*) Signalling in shafts and engine planes ?

*Modes of Working.*

11. What is the cause of accidents from falls of roof and sides ?—
    (*a*) What precautions would you take to lessen them ?
    (*b*) What general rules apply ?
12. What is pillar and stall, and what conditions would lead you to adopt this plan of working ?
13. Sketch the part of the mine in which you are now engaged.
14. An engine plane 373 yards long dips 1 in 5. What precautions would you take regarding manholes ? Sketch the plane and show the position of the manholes.
15. Name the different explosives. Give the advantages and disadvantages of each.

---

CARDIFF (2ND CLASS), 1892.

*Arithmetic.*

1. A pit works 8 hours per day, and it takes 1 minute for winding, and 3 minutes for changing with two cages—each cage carrying 1½ tons. How many tons are raised during the day ?
2. A heading is 300 yards long, 4 feet 6 inches high, 5 feet wide at the top and 6 feet at the bottom ; how many square feet of rubbing surface does it contain ?
3. Divide 73,621 by 31, and subtract the result from 2,684.
4. What are the total earnings of 50 men earning 8s. 7½d. per day, working 6 days per week, and 27 boys earning 2s. 6½d. a day, working 4 days per week ?
5. The pressure of steam in a cylinder is 110 lb. per square inch. How many tons and cwt. pressure are there when the cylinder is 500 square inches in area ?

*Modes of Working.*

6. Describe and illustrate by sketch—
    (*a*) Long wall ;
    (*b*) Pillar and stall :
    (*c*) Double stall ;
    (*d*) Nottingham.

7. Describe the method of sinking a pit 16 feet diameter, of opening out a new mine.
8. What would influence you in opening out a seam, whether to work it long wall or pillar and stall? Give your reasons.
9. Describe the colliery at which you are now employed, stating the seams worked and thickness of each, nature of roof. Give a section of the seams; state also the sizes of the headings, stalls, &c., giving the usual distances apart of each.
10. You find a dangerous accumulation of gas inside your double timber—
    (*a*) What precautions would you take?
    (*b*) What steps would you take to remove it?
    (*c*) What would you do to keep it from accumulating?

*Ventilation.*

11. What gases are usually found in the South Wales coal-field?
12. Describe the barometer and thermometer. Of what use are they n mining?
13. Describe the most modern safety-lamp known to you.
14. A heading is 6 feet 7 inches by 5 feet 8 inches. The anemometer shows 360 feet per minute. What quantity of air is passing?

*Mines Act.*

15. What do the special rules say regarding the duties of an under-manager? State fully.
16. What are the regulations respecting manholes on travelling roads?
17. What precautions would you take when driving towards a place likely to contain a large accumulation of water?
18. What are the regulations regarding firing a shot in a dry and dusty mine?
19. What does the Act say regarding the use of explosives underground?

---

Cardiff (2nd Class), 1891.

*Arithmetic.*

1. A pit in 17 days raised 498 tons 18 cwt. + 549 tons 16 cwt. + 648 tons 15 cwt. + 954 tons 17 cwt. + 546 tons 18 cwt. + 954 tons 17 cwt. + 671 tons 14 cwt. + 671 tons 14 cwt. + 641 tons 16 cwt. + 854 tons 19 cwt. + 789 tons 15 cwt. + 456 tons 18 cwt.—What is the average per day?

2. If six men earned £7 4s. in 6 days, how long would nine be earning the same amount?
3. A pit is 420 fathoms deep; the rope weighs 9 lb. to the yard. Find the total weight.
4. Show how you would enter the quantity of air passing in your note book. Supposing an air-way to be 11 feet by 7 feet 6 inches, what would be the cubical contents?

*Practical Working.*

5. What experience have you had in sinking? What strata are generally met with down to a depth of 420 yards? What would be the size of the pillar you would leave at the bottom of a shaft of this depth?
6. Describe long wall, Nottingham, pillar and stall, and double stall working. Show the advantages and disadvantages of the same by sketching, and state under what circumstances you would adopt each system.

*Ventilation.*

7. How would you construct an air-bridge over a main level?
8. How many methods of ventilating a mine are you acquainted with? Which is the best? Why?

*Mines Act.*

9. What does the Act specify with regard to shot-firing in a dry and dusty place?
10. What does the Act say as to the duties of a fireman? Where should the lamp station be placed?
11. What are the duties of banksman and chief hitcher as specified by the Coal Mines Regulation Act?

---

CARDIFF (2ND CLASS), 1890.

*Arithmetic.*

1. Divide 9,754 tons 19 cwt. 3 qrs. 27 lb. by 16.
2. What would be the amount of a workman's earnings, whose account is 79 tons 13 cwt. 3 qrs. of coal at 1s. 5½d. per ton; 14 yards air-way at 11d. per yard; seven cogs at 1s. 2d. each?
3. What amount of coal is there in a space worked out 15 yards wide, 7 feet long, the seam of coal being 2 feet 9 inches thick, and yielding 15 cwt. per cubic yard?
4. If 2,791 tons 13 cwt. 3 qrs. of coal cost £4,356 11s. 10d., what would it cost per ton?

*Working Coal.*

5. Describe and illustrate by sketch—
   (*a*) Long wall; (*b*) Double stall; (*c*) Single stall.

6. Describe and illustrate by sketch—
   (*a*) Upthrow; (*b*) Downthrow; (*c*) Wash-out.
7. State how you would proceed to tap water in old workings to the rise of your present workings.
8. Describe the colliery at which you are now engaged, and state the mode of working and distance between stalls, &c.

*Ventilation.*

9. What quantity of air will be passing per minute in a heading 8 feet 2 inches wide, 7 feet 10 inches high, the revolutions of anemometer being 1,199 in three minutes?
10. How would you proceed in search of the different gases found in coal mines? Where would you expect to find them?
11. Describe and sketch long wall workings with two or more panels or districts showing position of air crossings and different splits.
12. How would you proceed to measure the air in a roadway? Work a sum out, and show how you would enter it in a note book.

*Mines Act.*

13. What are the regulations as to signalling and manholes—
   (*a*) On travelling roads worked by machinery;
   (*b*) Other travelling roads?
14. What are the regulations as to—
   (*a*) Chains;
   (*b*) Rope slipping from drum;
   (*c*) Boilers?
15. What are the Special Rules and regulations as to the use of naked lights and safety lamps in your district?
16. State the regulations pertaining to water, bore-holes, &c.

---

Cardiff (1st Class), 1890.

*Machinery.*

1. Describe and illustrate by sketches a force pump, a suction and a hydraulic pump.
2. Given 50 gallons of water to be pumped out of a slope 1,000 yards in length, dipping 5 inches per yard, what kind of engine would you recommend?
3. State the advantages and disadvantages of electric lighting and signalling underground.
4. Describe the best kind of boiler and appliances for the safe and economical production of steam.

5. Explain why ice is found at the exhaust of a fan engine worked by compressed air.
6. What size engine would you require to raise 950 tons in 10 hours from a pit 600 yards deep? Give size of cylinder, length of stroke, diameter of drum, weight of cage and trams.

*Geology.*

7. Define anticlinal, synclinal, strike, level course, unconformable, and overlap.
8. Draw a map of the South Wales coal-field, and describe one of the seams in own words. How does the main anticlinal run? Name the principal faults in your district with their direction and throw.
9. Name the seams with which you are acquainted in the order in which they occur.
10. What fossils are found in the South Wales coal-fields?
11. How was coal formed? Give five reasons for anthracite and authorities for your statement.
12. Place these in their proper order:—Permian, coal measures, gneiss, old red sandstone, magnesian, limestone, granite.

*Mines Act.*

13. What are the duties of agent, manager, fireman, overman?
14. State regulations as to timbering, safety valves, manholes, and water-gauges.
15. State the rules which govern the use of safety-lamps.
16. What are the regulations regarding the use of explosives and shot-firing?
17. What are the regulations regarding ventilation?
18. What are the restrictions as to the employment of boys?

*Winning and Working Coal.*

19. What experience have you had in opening a mine and in sinking?
20. How would you secure a shaft in sinking through clift before walling, also through loose gravel?
21. What precautions have you to adopt in driving to the rise approaching old workings known to contain water?
22. Describe the various forms of cartridges, and the various methods of blasting.
23. If you had a large fall in your main return, how would you proceed?
24. Under what conditions would you work a seam by long wall, and when by pillar and stall? When by single and double road stall?

*Ventilation.*

25. What are the constituents of fire-damp? What is its specific gravity?
26. Where and when would you expect to find it? How is it tried?
27. What gases are formed after an explosion? In what proportion in the air is fire-damp most violently explosive? Will it burn in a pure state?
28. Sketch the different kinds of fans, and discuss the advantages and disadvantages of each.
29. Describe, with sketches, the uses as regards mines of the barometer, thermometer, anemometer, and water-gauge.
30. What are the advantages of splitting the air, and by what principles is it governed?

*Surveying.*

31. What is the magnetic variation? How is it allowed for in plotting?
32. Explain the principle of the vernier.
33. Does hæmatite or argillaceous ironstone affect the magnetic needle?

---

Cardiff (1st Class), 1891.

*Arithmetic.*

1. An air-way is 16 feet 4 inches wide, 8 feet 4 inches to the spring of the arch, and 1,750 yards long. Give the rubbing surface, sectional area, and cubical contents.

$$\text{Multiply } \frac{\frac{849}{874}}{\frac{891}{754}} \text{ by } \cdot1432 \times \cdot0186 \times \cdot6548.$$

2. At a colliery where the output of large coal is 12,227 tons, the output of small is 2,245 tons. What is the percentage of small to the total quantity, and proportion of small to large?
3. A pit 16 feet 4 inches in diameter, 300 yards deep, is to be walled with bricks 9 inches by 4 inches, by 3½ inches, the thickness of the walling is 18 inches; how many bricks will be required to wall the pit?

*Geology.*

4. Into what counties does the South Wales coal-field extend? Describe the outcrop.
5. Name the faults in the district you are acquainted with. Describe the effects they have on the coal measures, their direction, and name the seams (from the surface)

as they occur at the faults, and the average thickness between each seam.

6. What is meant by the terms stratified, unconformable, anticlinal, synclinal, and roll ?
7. Give the order of the formations.
8. Name the principal fossils found in the coal measures.

*Ventilation.*

9. What is the composition of fire-damp ?
10. What is the difference between carbonic acid and carbonic oxide ?
11. What is the peculiarity belonging to hydrogen gas ?
12. Sketch four safety-lamps and give the advantages and disadvantages of each.
13. An air-way is 12 feet 6 inches by 6 feet 9 inches, and passes 20,000 cubic feet of air per minute. Another air-way is 5 feet 6 inches by 6 feet 5 inches, and passes 30,000 cubic feet. Which requires greatest pressure. Give W.G. of each air-way.

*Mines Act.*

14. Give regulations as to employment of boys, girls, and women.
15. What are the regulations as to—
    (*a*) Use of explosives;
    (*b*) Inspection of machinery ?
16. Give the duties of managers, overmen, and firemen as specified in the rules of your district.
17. Give the general rules as to timbering, barometer, thermometer, and inspection by workmen.

*Modes of Working.*

18. Describe, sketch, and show by arrows the direction of air in—
    (*a*) Long wall ;
    (*b*) Double road system ;
    (*c*) Single road system.
19. How would you tap water to the rise of workings, and how would you get it from there ?
20. Describe and sketch—
    (*a*) Upthrow; (*b*) Downthrow ; (*c*) Roll; (*b*) Wash out.
21. The distance between two seams of coal in a pit is 30 yards, and the dip at the rate of 2½ inches per yard. It is proposed to drive an incline in the direction of the dip from the lower seam to the upper, rising 5½ inches per yard. What will be the length of the incline ?

*Surveying.*

22. A survey commences at H and returns to A, the bearings are 2·30 E, 60 E S, 10 secs. E S, 80 E, and 2·22 W. What would be the reading on the vernier of a right-hand dial ?
23. How would you find the position of an inaccessible point with pole and chain only ?
24. A piece of ground 1 rood 35 poles in area occupies 1 square inch of paper. What is the scale ?

*Engineering.*

25. An engine runs continually for 12 hours, the diameter of cylinder (double engine) is 24 inches, length of stroke 2 feet 6 inches, pressure of steam 44 lb. per square inch, and 82 revolutions per minute. What is the speed and power of the engine ?
26. Sketch and describe the Giffard injector.
27. Sketch and describe a Galloway boiler, and show all its fittings, and show in plan.
28. Give size of engine to bank 600 tons of coal in ten hours, up a drift 432 yards long, rising 1 in 2, the engine drawing four trams each journey, each tram 32½ cwt., weight of tram 15½ cwt., pressure of steam on engine 55 lb. Men are raised and lowered up and down the above drift. Give size and quality of rope you would have, what sort of attachment you would have between the trams, and how would you attach the rope to the trams ?
29. What weight and number of gallons of water are there in a column of pipe 360 yards long and 14 inches diameter ?
30. What size Cornish engine would you have to pump 300 gallons per minute from a pit 300 yards in depth ? Speed of engine to be taken into consideration.

---

Cardiff (1st Class), 1892.

*Geology.*

1. Sketch the South Wales coal-field, and show the distribution of the various qualities of coal, and state the peculiarities of the field, and what is meant by bituminous, steam, and anthracite coals respectively. Give composition of each.
2. Draw a section from north to south of the field at the part you live in. Show the same with sketch, and with all the strata down to the Old Red Sandstone.

3. Where is the "Cockshot Rock" situated? Describe its geological position, composition, and peculiarity.
4. Where is the "Millstone Grit" situated, and what is its peculiarity and composition?
5. Suppose a shaft were sunk to a depth of 500 yards in your district, what coals and strata would it pass through?

*Arithmetic.*

6. The royalties of two properties are:—
   (*a*) 9d. per ton (2,400 lb.) for large; and 3½d. per ton (2,400 lb.) for small; and the seam yields 27 per cent. small.
   (*b*) 7¾d. per ton (2,520 lb.) for large; and 4½d. per ton (2,520 lb.) for small; and this seam yields 23 per cent. of small.

   What would be the average royalty for each property respectively per imperial ton?
7. Find value of:—

$$\frac{8{\cdot}028}{\sqrt{450}} \times 1{\cdot}109.$$

8. The diameter of a drum for flat rope is 5 feet, rope $\frac{5}{8}$ inch, number of revolutions 34¼; what is the depth of the pit?
9. If a cubic yard of material weighs 2,600 lb., what is its specific gravity?
10. A beam 6 feet long has a circumference at one end of 18 inches and at the other end of 9½ inches; another beam 6 feet 6 inches long, with a diameter at one end of 6½ inches, and at the other end of 4 inches; another beam of 4 feet 5 inches long, area at one end 14·5 square inches, and at the other end 9·25 square inches. If a cubic foot of timber weighs 40 lb., what is the weight of the three beams?

*Mines Act.*

11. What is the number of the rule which provides for safety valves and steam gauges? State the rule.
12. What is the rule providing for inspection on behalf of the workmen?
13. Give fully the rules on explosives.
14. What are the special rules as to safety-lamps in your district?

*Surveying.*

15. Describe the dial; what is meant by the vernier, and how would you use it?

16. How would you lay out a railway curve with rod and chain only, and how would you find a straight line at right angles to another straight line with rod and chain only ?
17. State the following levels :—The distance from W to Z being 12 chains, starting from W, I fix between W and X, and read 2·08 at W and 4·15 at X. I then fix between X and Y, and find 1·68 at X and 9·05 at Y. I then fix between Y and Z, and find 4·03 at Y and 6·24 at Z. What is the height of each from a point 100 feet below Z ? Show the same by section, and if a line were drawn from W to Z, what would be its gradient ?
18. I place a mirror 100 feet from the base of a stack, and stepping back 5 feet from the glass I can just see the top of the stack in the centre of my mirror, my height being 5 feet 6 inches. What is the height of the stack ?

*Ventilation.*

19. What are the gases most frequently met with in mines? State fully the composition, properties, and specific gravity of each. How is the presence of each detected ?
20. What are the different modes of producing ventilation ? Give advantages and disadvantages of each, with sketches.
21. What is meant by the water-gauge ? Describe the water-gauge with sketch. If the water-gauge is 2·02 inches, and a door is 5 feet by 6 feet, what is the total pressure on that door ?
22. What size fan and kind would you put up to produce 120,000 cubic feet per minute in a mine ? If the water-gauge is 2·5 inches, what would be the size of engine ? Give all particulars.

*Modes of Working.*

23. What is meant by pillar and stall working ? Draw a plan showing workings open for 500 tons per day in a seam 5 feet 6 inches thick, dipping 1 in 18, with strong top, and show how you would ventilate it, giving dimensions of levels, headings, and stalls, and all distances in connection with working, size of air-ways and manholes ; and where would you adopt pillar and stall, and why ?
24. Make a plan of long wall work for 400 tons output per day from one shaft. The pits are sunk in middle of taking, dip 1 in 18, seam 5 feet 6 inches. How would you ventilate same ? Give dimensions of fan.
25. A collar in pillar and stall work is 7 feet wide inside, and the height of the road from under collar is 7 feet 6 inches. What would be the width of road inside arms at the rail

level? Give a sketch, with dimensions of timber used, and show how you would notch the same. The top being heavy, what precaution would you take in fixing?

26. What is meant by long wall? Where would you adopt it, and why?

*Machinery.*

27. What is a slide valve and a double beat valve? Give sketches. For what sized engines would you adopt the former for the latter?

28. Two balance valves are one 9 inches diameter, the other 12 inches diameter. What would be the lift of valve when full open?

29. An engine has an indicated horse-power of 300. Assuming stroke to be 6 feet 6 inches, 50 lb. pressure of steam, 35½ revolutions; what would be the diameter of the cylinder?

30. A road dipping 1 in 6 is 500 yards long; what kind of pump would you use to lift 1,000 gallons per hour? Give size of the pump and engines required.

31. Describe a Galloway boiler with two furnaces. Give plan and section showing the fittings fully, where fixed, and their respective uses.

---

CARDIFF (1ST CLASS), 1893.

*Mines Act.*

1. State fully what the Act says about the use of explosives underground.

2. What four provisions does the 10th Rule require in regard to safety-lamps in any mine or part of a mine?

3. What do the Special Rules of your district say with respect to the duties of the officials and workmen regarding ventilating doors, winding men, employment of boys below ground under the age of 16, manholes or places of refuge?

4. What does the Act say in regard to periodical inspection on behalf of the workmen, and timbering of working faces?

5. What does the Act say with reference to the employment of inexperienced men underground?

*Machinery.*

6. How do you ascertain the effective and indicated horse-power of an engine?

7. Given 30 lb. pressure of steam per square inch, what size engine—size of cylinders, stroke, revolutions per minute, size of drum and rope—would you require to raise 1,500

tons of coal from a depth of 400 yards, working 9 hours per day? What number, size, and construction of boilers are required for the above engine, and what size pipes are required to convey the steam to the engine from the boiler, and what pressure of steam ?

8. What size pumps and engine are required to raise 20,000 gallons of water per hour from a depth of 400 yards ?
9. Describe and sketch the surface condenser and the jet condenser.
10. What size hauling engine, length of stroke, rope, &c., would you require to draw 650 tons from a distance of 1,500 yards, rising 1 in 13, in 8½ hours, with effective pressure of steam of 30 lb. ? Give the horse-power of the engine.

*Arithmetic.*

11. 20 acres, 3 roods, 25 poles at £5 7s. 6½d. per acre.
12. One cwt. is bought at £7 ; for what must it be sold per lb. in order to gain 10 per cent. ?
13. If 5 men and 7 boys cut 125 tons of coal in 15 days, how long will it take 10 men and 3 boys to cut 75 tons (three boys being equal to one man) ?
14. There are 360 bricks in a cubic yard in a pit which is 16 feet in diameter, 1 foot thick of walling, 60 yards deep ; how many bricks are required ?
15. A ladder 46 feet long reaches from the road to a window 26 feet high, then it is turned against the other side of the street and reaches a height of 35 feet ; what is the width of the street ?

*Ventilation.*

16. An air-way is 16 feet 4 inches, what is its area ? With the velocity of 13 feet per second, what quantity is passing per minute ?—
    (*a*) How would you measure the quantity ?
    (*b*) How long would you take to measure it ?
    (*c*) How would you enter it on your note-book ?
17. A fan passes 18,000 cubic feet per minute. Sketch out a plan divided into five splits (or districts) showing separation doors, air-crossings, intakes, and returns.
18. Describe and sketch the Davy, Clanny, and Stephenson safety-lamps, and explain under what conditions each becomes unsafe in an inflammable mixture.
19. 60,000 feet of air pass through a pit 16½ feet diameter, with 1 inch of water-gauge. What is its velocity per second ? What is the horse-power of ventilation ?

20. Describe the best fan known to you, give its size, and explain its principle of action.
21. What are the chief gases met with in coal mines? Where are they found, and how are they detected, and when do they become dangerous?

*Working of Mines.*

22. A pit is sunk 500 yards to a 6 feet seam, dipping 1 in 18. State how you would open out and arrange the haulage roads at the bottom. Give sketch.
23. Describe and sketch where the rails are taken along the face, and at right angles to the face; and under what conditions would you adopt each?
24. What would guide you in determining the distance in walling a sinking pit? Describe with sketch the process of walling.
25. Describe the different modes of working coal in South Wales. Under what conditions would you adopt each mode, and what advantages has each system?

*Geology.*

26. Name and sketch the most characteristic fossils in and near the coal seams of this coal-field.
27. Define and sketch the following terms:—Symmetrical, unconformable, overlap, and cleavage.
28. Sketch a map of the South Wales coal-field. Name the principal faults, their approximate downthrow and direction.
29. Name the strata you would expect to meet in sinking a pit 500 yards deep in your neighbourhood, or in the pit at which you are working. Give a vertical section.

*Surveying.*

30. What is meant by a survey—
(*a*) With fast needle; (*b*) With loose needle?
Describe fully. Under what conditions does the loose needle become unreliable?
31. In driving a main heading towards the west a fault 37 yards is met with, dipping 6 inches in the yard towards the west. What length of drivage would you require to gain the seam on the other side of the fault, and how far east would the mouth of the drift be from the coal on the inner side of the fault?
32. What is the variation of the magnetic needle for this year, and how would you allow for it in plotting, and why?

33. What method would you adopt in surveying a large area, and how would you proceed to check the accuracy of same ?
34. Why is it necessary to show on plans the vertical as well as the horizontal position, and how would you find it and show it on the plan ?
35. What does the Act say in reference to keeping surveys and plans ?

---

Cardiff (1st Class), 1894.

*Geology.*

1. Give a description of the South Wales coal-field. Give a sketch of the coal-field, and mark the faults with their direction.
2. Name the strata and seams of coal in your district, the distance between each, and the distance from the surface.
3. Place the following in their proper order :—Carboniferous, Chalk, Old Red Sandstone, New Red Sandstone, and the Laurentian.

*Mines Act.*

1. Duty of fireman as required by Special Rules.
2. Duty of banksman and engineman.

*Machinery.*

1. Describe a winding engine with all its parts, from the bottom plate to a 4½-inch circular rope on the drum. Also sketch the cylinder, piston, and connecting rod.
2. How would you examine the rope of a winding engine and the rope of a slant ? How would you determine whether it required changing ?
3. Describe what kind of engine you would erect to haul 650 tons from a slant 450 yards long, dipping 1 in 2, with 50 lb. pressure of steam, to work on second motion.
4. How would you deal with a boiler if the water had gone dangerously low ?
5. (*a*) What is a condensing engine ?
   (*b*) What is a non-condensing engine ?
   (*c*) What is a compound engine ?

*Ventilation.*

1. How would you deal with two pits 400 yards deep full of gas, with a connection 200 yards from the surface ?
2. A heading 8 feet by 6 feet passes 5,000 cubic feet of air per minute. How much would a heading 10 feet by 6 feet pass per minute, both 1,500 yards long ?

3. A fan generates 60,000 cubic feet of air with a W.G. of 1·5, what is the H.P. in the air ? If the quantity is increased to 80,000, what would be the W.G. ?
4. What gases are met with in coal mines ? Where are they to be found, and how are they detected ? What are the results of their presence ?
5. State the advantages and disadvantages of splitting the air. Where would you split it to get the best results ?
6. What safety lamp do you prefer ? Give a brief description of it.

*Modes of Working.*

1. Describe the different methods of working coal in South Wales. Give the advantages and disadvantages of each. Where would you adopt them ?
2. Describe and sketch the method you would adopt if you had two pits 400 yards deep with the coal running in a gradient of 1 in 12. Sketch a plan to get 1,000 tons of coal per day ; mark the place of the two hauling engines, coal 5 feet thick.
3. Name the different explosives, and state what are the advantages and the disadvantages of each.
4. How would you sink through 60 yards of gravel ?

[*Other questions not given were set at this examination.*]

---

SOUTH-WESTERN DISTRICT (1ST CLASS), 1902.

*Arithmetic.*

1. For driving a drift 5 feet 10 inches by 4 feet 6 inches the men are paid 11s. per lineal yard. What is the price per cubic foot ?
2. Simplify the following expression and work out the answer :—

$$\frac{5}{8}\left\{\frac{\frac{432964}{2}+\frac{(5628920-2319784)}{3}}{106276}\right\}$$

3. An area of coal 545 acres, 4 feet 9½ inches thick, lying at an angle of 1 in 6 ; what is the sloping area, and what number of tons does it contain ? The specific gravity of coal being 1·20.
4. The average wages of the workmen employed at a colliery are 5s. 8d. per day. The sliding scale gives two successive advances of 10 and 15 per cent. What are the wages after

each advance ? If the sliding scale then gives a reduction upon the latter figure of 25 per cent., what will the average wage then be ?

5. Work out the cost per ton of the following items of expenditure on a monthly output of 23,340 tons :—

| | £ | s. | d. |
|---|---|---|---|
| Getting .. .. .. .. | 3,312 | 15 | 9 |
| Timbering .. .. .. | 532 | 12 | 3 |
| Haulage .. .. .. .. | 329 | 2 | 4 |
| Surface .. .. .. .. | 432 | 10 | 5 |
| General .. .. .. .. | 489 | 3 | 8 |

Can you suggest any constant figure the use of which would reduce the clerical work in obtaining the results ?

6. Extract the cube root of 997,002,999.
7. A tramway is made across a valley 610 yards long on an embankment 12 feet wide at the top and with sides sloping 1 in 2. What number of cubic yards of material will the embankment contain if the vertical depths to the bottom of the valley at the different distances are as follows :—

| *Distance.* *Yards.* | *Depths.* *Ft.* | *Ins.* |
|---|---|---|
| 127 .... | 15 | 6 |
| 373 .... | 20 | 0 |
| 467 .... | 12 | 6 |
| 610 .... | 2 | 0 |

*Surveying.*

1. Suppose the surface or the underground workings were steep, would you make any allowance in the measurements, and how would you do it ?
2. In the sketch (not reproduced) if D and U represent the relative positions of two shafts, which are only connected underground by means of galleries in the direction Da, ab, bc, cd, de, ef, fU, explain what method you would adopt to calculate (without plotting) from an underground survey made along the above galleries from D to U, the direction of the line DU, and the distance between the two shafts.

   Explain how, when this is done accurately, it is possible to abolish the use of the magnetic needle for underground surveys.
3. What is the present variation of the magnetic meridian ? Does it alter, and what means would you adopt to find the true north ?

4. Describe and sketch an ordinary miner's dial; and describe fully how you would make an underground survey with the magnetic needle, and also with fast needle, and show your method of booking in each case. Describe also the instrument used for levelling, and the method of making a levelling on the surface, and show your system of booking.

5. Two shafts at the same surface level, 500 yards apart, intersect the same seam of coal, one at 121 fathoms 4 feet 10 inches, and the other at 160 fathoms. What length of cross-measure drift, rising $\frac{1}{4}$ of an inch per yard, would be required to intersect the seam to the dip of the deepest shaft if deepened another 100 fathoms?

6. Compare the amounts of coal in a seam 4 feet 7 inches thick, measured at right angles to the dip, under the following conditions:—

(1) When the seam is flat.
(2) „ rises 6 inches in the yard.
(3) „ „ 10 „ „
(4) „ „ 19 „ „
(5) „ „ 58 „ „

7. Plot the following survey without a scale or protractor (to show your knowledge of the proportionate bearings of angles and distances):—

| *Bearings.* | *Distance in Links.* |
|---|---|
| N. 9° W. .... | 450 |
| N. 81° W. .... | 750 |
| S. 5° E. .... | 200 |
| S. 75° E. .... | 250 |
| S. 35° W. .... | 300 |
| S. 75° W. .... | 700 |

*Gases and Ventilation.*

1. Derive the formula $Pa = Ksv^2$, and explain why it expresses in general terms the conditions involved in ventilation calculations.

2. Describe the construction, principle of action, and use of the water-gauge, anemometer, thermometer, barometer, and steam-engine indicator.

3. The average temperature of a downcast shaft is 61 degrees Fahrenheit and the upcast shaft 122 degrees Fahrenheit; the depths of the shafts are each 200 fathoms, the barometer averages 30 inches. What is the difference of pressure per square foot in the shafts?

4. Under the following conditions calculate the ratio between the resistance of friction in the shafts and that in the underground workings :—

   Two shafts both 600 yards deep connected with underground workings of a total length of 10,000 yards, but which for the purposes of ventilation are divided into five separate splits.

   *Note.*—For the purpose of this calculation it may be assumed that all the shafts and galleries are of equal area and shape.

   Sketch any set of workings that would comply with the above conditions.

5. In Question 4 show how the ratio would be altered if all the air was passed round the whole of the underground workings without splitting.

   Compare the total pressures that would be required in the two cases for the same total amount of air passed through the shafts.

6. Do you consider shot-firing dangerous on a roadway where large quantities of air are passing, and why ?

7. How do you calculate the useful effect of a ventilating fan ?

*Practical Mining and Geology.*

1. Describe any means that may be adopted to supersede shot-firing in mines.

2. Describe, giving sketches, the various modes of working coal with which you are acquainted. Enumerate their relative advantages, and point out the principal difficulties met with in any of the systems, and give your suggestions as to how the general arrangement could be improved so as to overcome them.

3. State briefly what conditions you consider most favourable for—

   (*a*) Long wall work ;

   (*b*) Pillar and stall work.

   Give your reasons for deciding in any particular case that the coal seam should be worked by one of the above methods.

4. Sketch a frame (or plank), clay, brick, and a cast-iron dam.

5. Describe the classification of the rocks composing the earth's crust, arranging them in periods, systems, and groups.

6. Give a vertical section of the Monmouth, Forest of Dean, or Somerset coal-field, marking thereon the principal coal seams and their approximate depths.

7. Describe fully how you would propose to lay out the works under the following conditions :—

(*a*) Valuable coal seams have been proved to exist under a large area, and, as the most convenient sight for the shafts, is at a depth of 800 yards.

(*b*) These seams have always been found to be fiery when previously worked.

(*c*) Overlying the coal measures it is estimated that there are about 300 yards of Triassic Rocks, which are known to contain large quantities of water.

(*d*) The output of the pits is not to be less than 1,500 tons a day.

In your answer state clearly what machinery would be required for winding, pumping, ventilation, and any other purpose, and also make special mention of what precautions must be taken for the safety of the workmen.

*Colliery Plant and Machinery.*

Seven questions only to be attempted.

1. Explain fully what precautions you consider necessary with regard to the regular examination of winding ropes, having special regard to the safety of the men travelling in the shafts.

   Give your opinion as to the desirability of using both detaching hooks and safety catches. Can you point out any possible dangers connected with the use of the latter ?

2. Enumerate the different uses of electricity in coal mining, especially in fiery mines.

   Compare its advantages and disadvantages with those of compressed air as applied to underground haulage.

3. Describe an electric plant with which you are familiar.

4. What quantity of water would be discharged from a $1\frac{1}{2}$-inch bore-hole, 5 yards long, under a head of water of 100 feet ?

5. Describe the various modes you are acquainted with for raising water from the dip.

6. Sketch and describe giving measurements and description of material and fittings required of a Lancashire boiler, 30 feet by 8 feet diameter, to work at a pressure of 80 lb. per square inch ; also give sizes of brickwork flues and describe the method of setting the boiler.

7. What size and class of winding engine would you put down to wind 500 tons of coal per day of 10 hours (exclusive of time required to raise and lower men and other material) from a depth of 250 fathoms, the working pressure of

the boilers being 80 lb. to the inch? State sizes and description of ropes and chains, drum and pulleys you would use, and give the approximate cost of the plant.

8. Sketch and describe fully a ventilating fan (Guibal, or any other you are acquainted with), furnishing the principal dimensions.
9. What size of plough steel winding rope should be used for winding in a shaft 230 yards deep, with a load of 3 tons, and at the rate of 100 winds per hour?
10. How do you calculate the duty or useful effect of a steam engine? Give an example.

---

SOUTH-WESTERN DISTRICT (2ND CLASS), 1902.

*Arithmetic.*

1. The shaft pumps at a colliery raise 150 gallons of water per minute. If the pumps are stopped for repairs for 12 hours, what storage room is required for holding the 12 hours' water? Give the answer in cubic feet.
2. For driving a roadway 6 feet 6 inches wide by 6 feet 6 inches high, 15 shillings per lineal yard is paid for labour. What is the labour cost per cubic foot?
3. Extract the square root 514,089.
4. The repairing of 220 yards in length of a main road in a mine is let to a workman at the following rates:—
   (*a*) A set of double timbers every 6 feet at 1s. 7½d. per set.
   (*b*) Cutting bottom at 5½d. per yard forward.
   (*c*) Widening sides at 1s. 4½d. per sides forward.
   Work out the total cost of the repairs at the above rates.
5. Given that a cubic foot of water weighs 62·4 lb., and that the specific gravity of coal is 1·264, what is the weight of a cubic foot of coal?
6. During a shift of 8 hours a winding engine made 20 winds per hour, and at each wind brought up 4 trams. Each of the trams contained 12 cwt. of coal except 16 trams, which contained rubbish only. What was the output of coal from the pit in the 8 hours' shift?
7. If 13·146 cubic feet of air weigh 1 lb., what would be the weight of air in a round chamber 18 feet in diameter and 12 feet high?

*Ventilation.*

1. Describe fully the best method of producing ventilation for circulating large quantities of air underground.

2. Would you recommend a duplicate fan as a "stand by" at every colliery ventilated by a fan? Give the reasons for your answer.
3. What do you consider to be the maximum and minimum speeds at which air currents should travel in intakes, returns, and working faces? Give the reasons for your answer.
4. What are the uses of spare doors in a colliery, and where and how would you fix them?
5. Sketch a district in any colliery with which you are acquainted, and mark the courses of the ventilating air currents, and the position of sheets, doors, air crossings (if any), and regulators.
6. If an air-way is to be 6 feet high, how wide should it be to pass 10,800 cubic feet of air per minute at a velocity of 300 feet per minute?
7. A water-gauge placed in a door reads 2¼ inches. What is the ventilating pressure in pounds on one square foot of the door?
8. How would you ascertain the quantity of air per minute necessary to ventilate a colliery?

*Practical Mining.*

1. What are the obligations of colliers with regard to the safety of their working places, and with reference to the official examination of the working places?
2. In commencing to work a seam of coal what circumstances would guide you in deciding whether to adopt narrow or wide work?
3. Which would be the steeper part or parts of a self-acting incline plane? Illustrate your reply by a sketch.
4. Do you consider it safe or otherwise to fire shots in a colliery in main roadways where large quantities of cold air pass at a high velocity? Give the reasons for your answer.
5. Describe and illustrate by sketches a system of working a seam of which you have an intimate knowledge.
6. If an extensive fire broke out in one district of a colliery, what steps would you take to deal with it?
7. What is the chief cause of fatal accidents in collieries, and what are the best means of diminishing such accidents?
8. Give an example in which the working of a seam presents considerable difficulties in keeping the coal free from shale, stone, or dirt, and explain the best means of overcoming the difficulties.

South-Western District (1st Class), 1901.

*Arithmetic.*

1. The diameter of a circular shaft is 17 feet 6 inches. A brattice is fixed in the shaft as shown in the sketch on plan, the brattice being 8 feet 9 inches wide in the clear. What is the area of the shaft inside of the brattice ?
2. The area of a dam exposed to water-pressure is 6·25 square feet. The centre of the exposed area is 800 feet below the surface of the water which it is keeping back. What is the total water-pressure (in tons) on the dam ?
3. It is necessary to pump 300 gallons of water per minute from a shaft. The diameter of the bucket or plunger is 15 inches, and its stroke $7\frac{1}{2}$ feet. How many strokes per minute must the pump be driven—allowing 10 per cent. for loss ?
4. What sum, invested with interest at the rate of $4\frac{1}{8}$ per cent. per annum, would amount to £1,000 at the end of one year ?
5. If a winding engine raises 4,000 tons in nine days of nine hours per day, how many tons will be raised in eleven days of eleven hours per day ?
6. Reduce $3{\cdot}0\dot{8}1\dot{8}$ to a vulgar fraction.

*Surveying.*

1. Describe the various modes with which you are acquainted of surveying mines and of connecting the surface and underground plans.
2. Enumerate the advantages of having sections as well as plans of colliery workings.
3. Work out the acreage of the plot of ground drawn below and give its value at £75 per acre. (Sketch not given.)
4. How would you test the adjustment for collimation of a theodolite ? If found to be out of adjustment, how would you set it in order ?
5. To indicate your idea of angles and distance, plot the following survey without scale or protractor to a scale of two chains to an inch :—

| *Bearings.* | | *Distances in Links.* |
|---|---|---|
| N. 9° W. | .... | 450 |
| N. 81° W. | .... | 750 |
| S. 50° W. | .... | 200 |
| S. 75° E. | .... | 250 |
| S. 35° W. | .... | 300 |
| S. 75° W. | .... | 400 |

6. What is the smallest scale allowed for colliery plans? How often are the plans to be made up? How would you guard against errors arising from magnetic variation?

*Gases and Ventilation.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to (*a*) locked safety-lamps, (*b*) lamp stations?
2. What is the smallest quantity of fire-damp in air that can be detected with a bonneted Davy lamp? Describe how it is to be detected.
3. The total quantity of air passing in a mine ventilated by a fan is 250,000 cubic feet per minute with a water-gauge of 2·8 inches. What is the horse-power of the engine driving the fan—the useful effect of the machine being 58·5 per cent.?
4. If 20,000 cubic feet of air per minute pass through an air-way 50 square feet in area, what quantity will pass through if the area of the air-way is reduced to 35 square feet, the ventilating pressure remaining constant?
5. What would be the "drag" or water-gauge in inches when passing 6,000 cubic feet of air per minute through a tube 3,000 feet in length and 24 inches in diameter, the co-efficient of friction being ·0004?
6. How many cubic feet of air per minute would you provide for ventilating a colliery in which 400 men are employed and twenty horses—(*a*) When the workings are non-fiery and naked lights are used; (*b*) when the workings are fiery and safety-lamps are used?
7. How many ounces of carbon are contained in a mixture of 40 ounces of light carburetted hydrogen ($CH_4$) and 80 ounces of carbon dioxide ($CO_4$)?

*Practical Mining and Geology.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to—(*a*) Signals in shafts and underground; (*b*) reporting fatal and non-fatal accidents of all descriptions?
2. Describe and illustrate by sketches the mode by which you would proceed to clear a fall of roof and to re-timber a main underground roadway where the roof and sides were very broken and wet.
3. If the workings on a seam of coal 5 feet in thickness approached an extensive waste containing water with a head of 60 yards, describe and show by sketches how

you would tap the water and make the necessary arrangements for its inflow not to exceed the capacity of the pumps.

4. Describe the process of sinking and walling a circular shaft 20 feet in diameter in the clear, 500 yards deep, and of dealing with 10,000 gallons of water per hour met with in rock at 100 yards of the depth.
5. Describe the best apparatus with which you are acquainted and the means of using it for driving a hard heading where the use of explosives is not permitted.
6. Sketch the boundaries of the South Wales, the Forest of Dean, or the Somerset coal-field, and give an approximate vertical section of the principal seams.
7. Show the geological order of succession of the following rock formations, beginning at the top:—Archæan, Cambrian, Carboniferous Limestone, Coal Measures, Devonian, Millstone Grit, Permian, Silurian, Trias.

*Colliery Plant and Machinery.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to lowering and raising men?
2. Give sketches of good designs of lifting and forcing pumps for use in shafts.
3. For what purposes has electricity been applied in collieries? Give a detailed description of an electrical plant for colliery work with which you are familiar.
4. Explain the object of using extension piston rods in horizontal engines, and give your opinion as to how they answer in practice, and as to the best means of enabling them to satisfy their purpose.
5. Show by sketches and explain the methods of fitting tubes in the front and back tube plates of a boiler of the locomotive type.
6. Give a hand-sketch of the form of rim of an ordinary pit-head pulley. State what radius of curve you would adopt for the bottom of the groove for carrying a rope of $1\frac{1}{8}$ inch diameter.
7. What would be the objection to the formation of a partial vacuum within a boiler when it is being cooled down? How would you guard against its formation?

---

South-Western District (1st Class), 1899.

*Arithmetic.*

1. A building with gable ends is 45 feet long by 31 feet wide, inside measurements. It is 21 feet high to the square of

eaves and 31 feet to the ridge, and it cost £850. What was the cost of building per cubic foot of capacity ?

2. How many gallons of water would fill a tank 57 feet by 33 feet by 7 feet, and what would be the weight of the water in tons ?
3. What is the pressure in pounds per square inch of a column o water 105 feet high ?
4. What is the total surface in square inches of a solid cylinder 6 feet long, and 3 feet in diameter ?
5. How many tons are there in an acre of a seam of coal 6 feet thick, the specific gravity of the coal being 1·27 ?
6. The average cost of sinking a shaft to a depth of 600 yards amounted to £15 per yard, but 22½ per cent. of the distance sunk cost 40 per cent. more than the average. What was the cost per yard for sinking the remaining 77½ per cent. ?

Maximum marks, 120.

*Surveying.*

1. On a plan, the scale of which is six chains to an inch, how many acres would a square inch represent ?
2. Explain the process of levelling with a dumpy level. Show how a levelling book is kept, and explain how the levelling is plotted.
3. Find the length in feet of an arc of 40 degrees 33 minutes, the radius being 11 feet 6 inches.
4. What is the diameter in yards of a circular piece of ground having an area of one acre ?
5. Two shafts are sunk from the surface 300 yards apart. Shaft No. 1 is 400 yards deep, and Shaft No. 2 is 350 yards deep. The surface at the top of Shaft No. 2 is 20 yards lower than at the top of shaft No. 1. It is necessary to drive a heading direct from the bottom of Shaft No. 1 to the bottom of Shaft No. 2. What will be the length of the heading and its gradient ?

Maximum mark, 100.

*Gases and Ventilation.*

1. Define the expression "travelling roads" and "ventilating district" according to the Coal Mines Regulation Act, 1887.
2. A ventilating furnace produces 100,000 cubic feet of air per minute with a ventilating pressure of 7·5 pounds per square foot. What is the effective horse-power of the work done by the furnace ?

3. What are the physical properties of the gases commonly found in coal mines?
4. Show how you would ventilate the workings on the accompanying plan. [Plan not reproduced.]
5. How would you satisfy yourself that a fiery colliery is adequately ventilated?
6. How would you ventilate a shaft of 20 feet diameter inside the walling which has to be sunk 700 yards through hard rock without communicating with any other shaft or working?
7. The volume of air passing in an upcast shaft 300 yards deep and 15 feet in diameter is 235,000 cubic feet per minute. What is the water-gauge due to the resistances in the shaft, the co-efficient of resistance being ·0004?

Maximum marks, 140.

*Practical Mining and Geology.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to—
   (*a*) Single Shafts;
   (*b*) Raising and lowering men?
2. What are the provisions of the Coal Mines Regulation Act, 1887, under the General Rule, as to "Propping timber?"
3. Give the names of some of the ammonium nitrate and of some of the nitro-glycerine explosives found in the list of Permitted Explosives, and state which you prefer to use for driving in hard ground and for getting coal.
4. Sketch and describe how you would work an area of coal lying 800 yards to the dip of the pits in water-bearing strata dipping 3 inches to the yard, and state how and by what means you would bring the coal and the water to the pit bottom.
5. Describe and illustrate by sketches the method of timbering you would adopt for sinking a round shaft, 15 feet in diameter, through disturbed coal measures where the ground is nearly dry and can be easily excavated by picks.
6. Describe the principal characteristics of the geological formations immediately below and above the "Carboniferous System."
7. To what cause are "wash outs" or areas of barren ground in coal seams to be attributed?
8. To what cause are "overlaps" in coal seams to be attributed?

Maximum marks, 160.

*Colliery Plant and Machinery.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, under—
   General Rules as to "Prevention of overwinding;"
   General Rule as to "winding drums;" and
   General Rule as to "steam boilers."
2. Give a code of signals for—
   (*a*) A sinking pit;
   (*b*) A winding pit (from one level).
3. What should be the thickness of the shell plates of a steel boiler 8 feet in diameter to withstand a working pressure of 100 lb. per square inch taking 6 as a factor of safety?
4. Specify the type of engine, giving the cylinder dimensions and diameter of drum, which you would erect for sinking a pit 300 yards deep. State the weight of the load it would raise and what pressure of steam would be necessary for working the engine.
5. State what you know about driving rock-drills by compressed air, and describe any rock-drilling plant of that class with which you are acquainted.
6. Give the diameter of a pump working-barrel to lift in 10 hours as much water as one of 10 inches in diameter would lift in 18 hours, the length of the stroke and the number of strokes per minute of both pumps being the same.
7. The high-pressure cylinder of a compound engine is 19 inches in diameter, and the piston rod is 3¼ inches in diameter in the front and 3 inches in the back end. The piston speed is 420 feet per minute. Indicator diagrams show that the mean steam pressure is 42·9 lb. per square inch in the high pressure and 9·7 lb. per square inch in the low-pressure cylinders. Work out the horse-power developed in the high-pressure cylinder.

Maximum marks, 140.

---

SOUTH-WESTERN DISTRICT (2ND CLASS), 1899.

*Arithmetic.*

1. What would be the cost of a log of timber 35 feet long by 18 inches square at 1s. 6½d. per cubic foot?
2. How many tons are there in a pillar of coal 30 yards long by 20 yards wide by 5 feet thick—allowing 18½ cwt. to each cubic yard?

3. Two colliers, working as partners, earn £2 11s. 6d. in a week for cutting coal and for sundry labour. What will their earnings amount to if their rate of wages is advanced $3\frac{3}{4}$ per cent.?
4. Calculate to two places of decimals the circumference and area of a circle 7 feet in diameter.
5. What would you pay a collier for 25 tons 3 cwt. of coal at 1s. $3\frac{1}{2}$d. per ton plus an advance of 25 per cent. ?
6. In one district of a colliery 97 cogs and 43 pairs of timber were stood for a get of 1,500 tons of coal. Allowing twice as much coal for each cog as to each pair of timber, how many tons of coal were worked for each cog and each pair of timber respectively ?
7. What would be the labour cost for building a screen wall 73 yards long, 23 feet high, 6 feet wide at the base and tapering upwards to 3 feet at the top, taking the labour rate at 3s. 9d. per cubic yard ?

Maximum marks, 140.

*Ventilation.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, under General Rule 3, as to ventilation ?
2. What are the provisions of the Coal Mines Regulation Act, 1887, under General Rule 33, as to atmospheric pressure and temperature ?
3. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to measuring and recording air-currents ?
4. Show how you would course the currents of air for ventilating the headings, represented in the following sketch :— [Plan not reproduced.]
5. What are the advantages and disadvantages of regulators in mines, and where would you fix them ?
6. What size of air-way is required to pass 20,000 cubic feet of air per minute at a velocity of $5\frac{1}{2}$ feet per second ?
7. Give the names of the dangerous gases commonly met with in coal mines, and state what you know of their composition.
8. Explain the uses and advantages of spare air doors, and state where and in what positions you would fix them.

Maximum marks, 160.

*Practical Mining.*

1. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to a coal getter working alone ?

2. What are the provisions of the Coal Mines Regulation Act, 1887, under General Rule 2, as to return air and fire?
3. What are the provisions of the Coal Mines Regulation Act, 1887, under General Rule 8 as to naked lights?
4. What are the provisions of the Coal Mines Regulation Act, 1887, with regard to ambulances?
5. Describe the shaft pumps in use at any colliery with which you are acquainted.
6. Give a sketch descriptive of the way in which you would cut and set double timbers to resist top and side pressure.
7. Explain what you consider to be the best means (having regard to safety and economy) of stowing or gobbing in fiery mines where sufficient rubbish is not always easily obtainable.
8. Describe in detail the system of working coal with which you are best acquainted, giving section of coal, nature of roof and bottom, and dip of strata.

Maximum marks, 160.

---

SOUTH-WESTERN DISTRICT (1ST CLASS), 1893.

*Arithmetic.*

1. Simplify the following expression, and work out its value to two places of decimals:—

$$\sqrt{\frac{2467 \times 3\frac{7}{8} - 43{\cdot}125}{145}}$$

2. A colliery produces per week 6,500 tons of large coal, and 1,250 tons of small. The wages cost on the total output is 3s. 4½d. per ton. What is the cost per ton of the large coal, when it is debited with the entire wages expenditure, and credited with the value of the small coal at 2s. 10½d. per ton?
3. A contractor delivers coal at pit bank at the rate of 4s. 3·85d. per ton. What rates should he be paid (*a*) at an advance of 13¼ per cent., (*b*) at a reduction of 5¾ per cent. on the above rate?
4. An engine makes 35 revolutions per minute. The stroke is 5 feet. Give the ratio between the travel of the piston and the movement of the crank pin for each revolution, and the total number of feet which the crank-pin moves in $1\frac{5}{7}$ second.
5. In a colliery where the faces or roads are driven 9 feet wide, and rectangular pillars, of 21 feet by 12 feet, are left for

support—what percentage of the seam is removed; and what is the percentage increased to by driving a 9 feet road through the breadth of each pillar?

*Surveying and Geology.*

1. Explain what is understood by the terms "true north" and "magnetic north," and how each is ascertained.
2. Explain what steps you would take for connecting an underground survey with a surface plan, so as to secure their true relationship.
3. Give examples to show your methods of booking observations in a survey book and in a level book.
4. State what comparisons you can make between the strata of the South Wales coal-field and the Bristol coal-field.
5. (*a*) What are the characteristics of the Millstone Grit Formation? (*b*) Illustrate, by a sketch, the relative positions of the Millstone Grit, the Mountain Limestones, and the Coal Measures.
6. Write down in order the systems of rocks from the Lias to the Silurian.

*Gases and Ventilation.*

1. Describe the chemical and physical properties of air.
2. Describe the construction and action of a maximum and minimum thermometer, and give a sketch of the instrument.
3. Would the graduation of the tube of a thermometer be affected by altering the capacity of the bulb? Give the reason for your answer.
4. The total ventilating pressure on an underground door is 390 lb., with a water-gauge of 2·5 inches. Give the height and width of a door satisfying these conditions.
5. What steam-driven mechanical ventilator would you employ for obtaining 150,000 cubic feet of air per minute in a mine with a water-gauge of 1·75 inches at the ventilator? (*b*) What power would you expect the engine to indicate to produce the above result? (*c*) What would be the efficiency of the ventilating mechanism?
6. Describe the composition and properties of fire-damp, and show what chemical change takes place when a mixture of fire-damp and air is exploded.
7. What is required by the Coal Mines Regulation Act as to the ventilation of mines, and how could you satisfy yourself that the Act is complied with in a colliery?
8. What is the use of air-crossings, and how would you construct one?

*Practical Mining.*

1. Describe the provisions of the Coal Mines Regulation Act with regard to the duties of managers and under-managers.
2. Draw a section of the coal, floor, and roof of any seam worked in a colliery you are acquainted with, and explain the method of working the coal and of ventilating the colliery.
3. Illustrate, by sketches, what you consider to be the most convenient and best arrangement of bit-bottom roads and sidings for a colliery drawing 600 tons of coal in nine hours, from a depth of 450 yards.
4. Some underground workings are very liable to take fire by spontaneous ignition. How is it explained ?
5. Where is the best place for placing the water-gauge for ascertaining the ventilating pressure at fan drift ? Give your reason, and illustrate your answer by a sketch showing the position of the water-gauge.
6. In what way might underground hauling engines, driven by compressed air, cause a danger of fire, and how is the danger to be guarded against ?
7. Describe the precautions necessary for driving an underground road to meet a point in old workings plotted from magnetic surveys 20 years ago.
8. How would you conduct shot-firing in dry and dusty workings where fire-damp sometimes occurs ?

*Colliery Plant and Machinery.*

1. A 30 H.P. Lancashire boiler, used at a colliery, has to be carefully examined and then tested. Describe how you would make the examination and test.
2. Describe the action of the Cornish type of pumping engine.
3. Draw a sketch showing a transverse section of a good design of pit-head pulley for carrying a wire rope of $3\frac{1}{4}$ inches circumference, bearing a five-ton load. The sketch should not be less than 4 inches in length, and should be neatly finished. The candidate should specify below the sketch the material or materials of which the pulley should be made, and the method of securing the arms to the rim and the boss.
4. It is necessary to transmit mechanical power from the surface of a colliery down a shaft and into the workings by the agency of electricity, so as to obtain 10 H.P. effective, from a hauling engine underground. Explain how this should be done, and enumerate the appliances

necessary for the installation. State, also, how much power you would provide at the surface to supply the 10 H.P. effective, at a total distance of 1,000 yards, including the depth of the shaft.

5. Explain how a steam engine is indicated.
6. Give two examples to show the practical usefulness of indicator diagrams.

---

SOUTH-WESTERN DISTRICT (1ST CLASS), 1892.

*Arithmetic.*

1. What is the product of $\sqrt{\frac{1785 \times 7\frac{3}{8} - 46{\cdot}75}{170}}$ carried to two places of decimals ?
2. If £25,119 will purchase 235 acres of mineral property, what number of acres, roods, and perches will £11,000 purchase, and what would be the price per acre ?
3. If the average cost of sinking a shaft 450 yards deep will be £23 per yard, and 25 per cent. of the strata being hard rock will cost 40 per cent. more than the average rate of £23, what will be the cost per yard for sinking the remaining 75 per cent. ?
4. The diameter of a pit after walling is 10 feet, the thickness of brick lining is 9 inches. How many cubic yards of ground will have to be taken out in sinking the pit to a depth of 60 yards ?
5. A colliery produces 8,000 tons of large coal per week, and 2,000 tons of small, at a wages cost of 4s. 6d. per ton on the total output of 10,000 tons ; what will be the cost per ton of the large coal, if it be debited by the entire wages expenditure and credited with the value of the small coal at 4s. 9d. per ton ?
6. Divide ·084035 by 34·3, and express the answer by a vulgar fraction.
7. How many gallons of water will a pump of the following dimensions throw in 12 hours, allowing 10 per cent. for loss ?—Diameter of pump, 18 inches ; length of stroke, 8 feet ; number of strokes per minute, 8.
8. The surface of a solid cube has an area of 11,904 square inches. How many cubic feet does the solid contain ?
9. How many feet must a ton be raised in one minute to give 100 horse-power effective ?

*Surveying, Mapping, and Geology.*

10. Define the conditions under which you would make theodolite and magnetic surveys respectively, and describe the modes of plotting.
11. Describe how you would record an underground survey in a survey book.
12. Describe the provisions of the Mines Regulation Act, 1887, with regard to the keeping of plans of the workings.
13. The sides of a five-sided rectilineal figure ABCDE taken in order AB, BC, CD, DE, EA are 18, 24, 30, 24, and 18 respectively. The angles ABC and AED are right angles; find the area in feet to two places of decimals.
14. Find the acreage of a field which has two sides parallel and its other two sides equal to one another, the parallel sides being respectively 370 and 250 links, and the other sides 100 links long.
15. Give a sketch of a "fault" in a coal seam, illustrate the method usually adopted in measuring the amount of "throw," and in showing the fault on a colliery plan.
16. By means of instruments provided, plot on paper to a scale of 2 chains to an inch—

N. 85 W., 665.
N. 41·15 W., 705.
N. 21·30 W., 950.
N. 44·45 E., 520.
S. 69·30 E., 800.
S. 12·45 E., 1605.

17. The following are the several levels taken underground of a proposed inclined plane; plot, by means of instruments provided, to any horizontal and vertical scale you choose, and work out the average inclination in inches per yard:—

| Back sight. | Fore sight. | Horizontal distance Links. |
|---|---|---|
| 10·85 | 1·85 | 100 |
| 8·45 | 1·17 | 100 |
| 11·02 | 3·65 | 100 |
| 8·52 | ·67 | 100 |
| 9·94 | 3·34 | 100 |
| 8·03 | ·89 | 100 |
| 10·72 | 3·50 | 100 |
| 8·55 | 2·55 | 100 |
| 8·43 | 1·35 | 100 |

18. The base of one triangle is 50 yards, and its altitude 3 yards; the area of another triangle is double the area of the first triangle, and its base 4 yards. Find its altitude.

*Gases and Ventilation.*

19. Describe the provisions of the Coal Mines Regulation Act of 1887 with regard to ventilation, inspection, and working with locked safety-lamps.
20. Name the principal gases met in coal mines, and give the chemical symbol for and the specific gravity of each gas.
21. If the effective horse-power of a ventilating furnace equals 7 lb. per square foot, what is the quantity of air per minute ventilating the mine?
22. For a main intake or return, would you prefer one large air-way to two small ones whose joint areas are the same as the large one? Give your reasons fully.
23. See accompanying plan. Indicate thereon by arrows and other signs how you would ventilate the workings shown on the plan, indicating splits, air-crossings, door-stoppings, &c., proper for working a fiery seam. [Plan not reproduced.]
24. A ventilating fan running at 45 revolutions per minute produces a water-gauge of 1·75 inches, what will the water-gauge be if the fan speed is increased to 60 revolutions per minute?
25. Describe the construction of an underground ventilation furnace and its connection with the upcast of a fiery colliery.
26. Show an air-crossing most suitable in a fiery mine to stand the effects of an explosion.
27. If 459 cubic feet of air at ·0 degreee Fahr., and 30 inches barometer, weigh 39·7586 lb., what will be the weight of a cubic foot at 60 degrees Fahr. and 100 degrees Fahr. respectively (the barometer remaining constant)?
28. Describe the properties of carbonic oxide gas (CO) and circumstances under which it has occurred in mines.

*Practical Mining.*

29. Describe the provisions in the Coal Mines Regulation Act of 1887 with regard to the duties of colliery manager.
30. Illustrate, by sketches, neatly drawn, the various systems adopted in working the veins of coal you are best acquainted with, giving sections and full particulars.
31. State what gradients with or against the load you would prefer for endless rope and main and tail rope haulages, and give your reasons.

32. Sketch and describe what you consider to be the best method of working to the rise a "fiery" seam of coal 5 feet thick, with the following section of roof and floor:—

| | Feet. |
|---|---|
| Roof, strong cliff .. .. .. | 4 |
| Clod .. .. .. .. | 1 |
| Clod .. .. .. .. | 5 |
| Floor, fire-clay .. .. .. | 1 |
| Hard cliff .. .. .. | 2 |

33. State your reasons why you would (if it could be applied conveniently underground) use a steam engine for pumping or hauling in preference to compressed air or electricity.

34. Having a pit 300 yards deep, state size of pillars you would leave to protect it; state also the chief considerations that would guide you to determine this.

35. Describe and illustrate by sketches and dimensions the way you would lay out roads at the bottom of the drawing shaft of a colliery when the quantity required to be drawn is 600 tons per day of one shift.

36. What are the provisions of the Coal Mines Regulation Act of 1887 with regard to the employment of skilled and unskilled labour underground? State also the regulations as to employment of youths and boys under 16 years of age.

37. Describe the best plan of timbering ordinary roads with which you are acquainted, and sketch the "joggles" or "notchings" you would cut for resisting "top" and "side" pressure; state also the conditions under which you would expect to find the greatest "heaving" or "pucking" of the bottom in roads and workings.

38. What are the conditions to be observed as prescribed in the Coal Mines Regulation Act of 1887 for shot-firing in "fiery" and "non-fiery" mines?

*Colliery Plant and Machinery.*

39. Give a sketch of a section of rail suitable for an engine plane underground; show how you would fasten the joints, and give the approximate cost per yard of the road, including labour and materials—weight of tram and load running on rails may be taken at 38 cwt. or 14 cwt., at candidate's option.

40. Sketch neatly side and end view of a colliery tram suitable to carry either 30 cwt., 20 cwt., or 10 cwt. of coal through the workings of any seam you can mention, and fill in principal dimensions.

41. Give some illustrative details of a shaft and the required fittings suitable for raising 800 tons per shift of eight hours.
42. Describe some of the principal methods of transmitting power from a distant motor at the surface to machinery underground.
43. It is required to raise 300 gallons of water per minute from a mine 300 yards deep. Give a general idea of the plant you would adopt for the work.
44. What will be the horse-power of a hauling engine necessary to haul 500 tons of coal in eight hours along a road 2,200 yards long, rising 1 in 12, main and tail system ?
45. State what measures you consider necessary for the proper supervision of steam boilers in use at collieries.
46. The annexed indicator diagram shows the action of the steam in the cylinder of a non-condensing engine. What defects in the engine are disclosed by the diagram ? [Diagram not reproduced.]
47. Illustrate by a hand-sketch the two eccentrics, eccentric rods, and slot-link reversing motion of a winding engine.
48. Describe fully what arrangement of signals you would adopt for winding from two different levels or stages in a shaft, as occasion may require throughout the shift.

---

South-Western District (2nd Class), 1892.

*Arithmetic.*

1. If a pillar of coal contains 5 tons 14 cwt. 2 qrs. 19 lb., what is the weight in pounds ?
2. How many gallons are there in $7\frac{1}{2}$ tons of water, taking the weight of 1 gallon at 10 lb. ?
3. If a drivage is 45 feet long, $6\frac{1}{2}$ feet high, and 8 feet wide, how many cubic feet of air will it contain ?
4. If an "adit" or "heading" rises $84\frac{1}{2}$ feet in a total length of 1,352 yards, what is the rise per yard ?
5. If six men earned £54 15s. in equal shares, but had to deduct a sum of £3 15s. 3d. for stores used by them, what would be each man's share of the balance remaining ?
6. A round pit 12 feet diameter, after being sunk to a depth of 60 feet, is accidentally filled with water; what is the quantity of water it contains, supposing 1 cubic foot equals $6\frac{1}{4}$ gallons ?
7. How many cubic yards of materials are taken out in driving a level 48 yards long, 8 feet wide, and 5 feet high ?

8. Subtract £575 10s. 9d. from £759 8s. 4d., and divide the remainder by 4.
9. Multiply 656,359 by 378.
10. If men are paid at the rate of 4s. 3d. per day, what would be the weekly wages of 65 men working 5½ days each week?

*Ventilation.*

11. How many air-ways, 4 feet square each, would be required to give as much area for air to travel in as one air-way 12 feet square?
12. What quantity of air per minute will pass through a shaft or circular air-way, 10 feet diameter, when the speed of air-current is 5 feet per second?
13. Explain the use of the water-gauge, and state where it should be fixed in order to ascertain the "drag" in the underground workings.
14. State what you know about the nature and properties of fire-damp and black-damp.
15. What class of safety-lamp do you consider the safest for use by the miner? Give your reasons.
16. Sketch a small district of a colliery with which you are acquainted, showing by arrows the plan of coursing the air from the "intake" round the face of the workings, and back to the "return."
17. What is the circumference of a round shaft whose diameter is 17 feet 6 inches?
18. The thermometer registers 60·1 degrees, 57·9 degrees, 58·4 degrees, 53·7 degrees, 58·6 degrees, 61·4 degrees, 59 degrees Fahr., on seven days of the week; what is the average temperature for the week?
19. In a mixed light mine (*i.e.*, where locked lamps and naked lights are both used), state what are the requirements of the Mines Regulation Act.
20. What are the requirements of the Coal Mines Regulation Act as to the ventilation of mines?

*Practical Mining.*

21. What are the requirements of the Coal Mines Regulation Act of 1887 with regard to the duties to be discharged by the under-manager of a colliery?
22. Illustrate by sketches the best method of setting "props" or "chocks" or "cogs" in a thin seam of coal worked long wall in steep measures.

23. Describe the mode of working any seam of coal with which you are acquainted, and illustrate by sketches the positions of main and branch headings and ordinary roadways or stalls.
24. Sketch an air-bridge for carrying a main return over an intake air-way, and explain in writing how it should be constructed.
25. What precaution would you take in approaching old workings likely to contain an accumulation of water?
26. What are the regulations of the Coal Mines Act with regard to manholes on underground incline and engine planes?
27. What are the provisions of the Coal Mines Regulation Act with regard to the use of explosives?
28. What does the Coal Mines Regulation Act require as to "sprags" or "holing" props?
29. What are the requirements of the Coal Mines Regulation Act as to—
    (a) Inspection or examination of a mine where two shifts are employed?
    (b) Examination of safety-lamps?
30. What is the advantage of noticing the changes of the barometer at a colliery?
31. Many colliers are injured or killed by falls. State what you have noticed to be the principal causes of such accidents, and how they may be prevented.
32. What is meant by good discipline in a colliery?

---

SOUTH-WESTERN DISTRICT (1ST CLASS), 1892.

*Arithmetic.*

1. Find the square root of 572·14096 to three places of decimals.
2. Reduce $\frac{7{\cdot}75}{9}$ of $\frac{2\frac{1}{2}}{2\frac{5}{8}}$ of $\frac{20}{31}$ to a decimal quantity.
3. A tank built to the form of an octagon is 6 feet deep, and each side is 7 feet long. These are inside measurements. How many cubic feet of water will the tank hold?
4. Find in inches, to three places of decimals, the side of a square which has an area of 41·9 square feet?
5. The capacity of a chamber is 6,348 cubic feet. It is filled with an atmosphere composed by volume as follows:—N, 79·00 per cent.; O, 20·96 per cent.; $CO_2$, 0·04 per cent. What number of cubic feet of each gas is contained in the chamber?

6. A pillar of coal, 150 yards long by 44 yards wide, has been completely worked out and sent to bank. The total weight of the coal is found to be 12,430 tons, and its specific gravity 1·25. What was the thickness of the pillar ?

*Surveying and Geology.*

7. Give a description of the ordinary miner's dial and of a theodolite.
8. Give a description of the Dumpy level, and show how you would record staff readings and variations of levels in a book.
9. Make an ink sketch of a vernier, and explain its use and value when fitted to instruments.
10. The sides, AB, BC, CD, DA, of a field measure 28, 45, 60, and 57 yards in length respectively. The angle ABC is a right angle. Find the area of the field in square yards to two places of decimals.
11. Explain fully how you would keep up a colliery plan and use it as a check upon the quantity of coal raised.
12. Illustrate by sketches in ink the way in which coal seams are often "thrown" by faults and igneous dykes, and explain the common effect of such faults and dykes upon the adjacent coal.
13. Name the geological system of rocks from the Oolitic to the Cambrian.
14. Describe the chief characteristics of the Carboniferous system, and name the fossil remains you have seen in the coal measures.
15. State what is the true position of the Carboniferous Limestone in relation to the Coal Measures, and mention an exceptional case in England where a large area of Carboniferous Limestone is found in connection with the Coal Measures in a contrary order as to position.

*Surveying (Plotting).*

16. By means of instruments provided, plot the following survey on paper to a scale of two chains to an inch :—

| Bearings. | |
|---|---|
| N. 30° 45′ E. .. .. .. | 1,110 links. |
| S. 70° 00′ E. .. .. .. | 1,135 „ |
| S. 53° 15′ W. .. .. .. | 1,610 „ |
| N. 41° 00′ W. .. .. .. | 540 „ |

17. Show how you work out the following levels taken off a field-book :—

| Back Sight. | Fore Sight. | Rise. | Fall. | Reduced Levels. |
|---|---|---|---|---|
| 11·95 | 9·77 | | | |
| 9·77 | 4·88 | | | |
| 4·88 | 1·94 | | | |
| 1·94 | 4·08 | | | |
| 12·05 | 5·05 | | | |
| 5·05 | 5·72 | | | |
| 5·72 | 1·92 | | | |
| 1·92 | 2·73 | | | |

*Gases and Ventilation.*

18. Enumerate the noxious gases found in collieries, and state the composition of each.
19. In what ways may danger arise from coal-dust in collieries ? Describe the means now employed for counteracting the danger.
20. Describe fully the provisions of the Coal Mines Regulation Act of 1887 with regard to ventilation, inspection and working with locked safety-lamps.
21. What are the conditions and precautions under which shot firing may be permitted in a fiery mine ?
22. Define the term " ventilating district," referred to in the Coal Mines Regulation Act of 1887, and illustrate your answer by a diagram in ink.
23. Explain the advantages of splitting the air in ventilating collieries, and state what would guide you in deciding where the main current should be divided and joined to derive the greatest advantage.
24. Give a description, with ink sketches, of the safety-lamp you are best acquainted with.
25. The temperatures of the air in the downcast and upcast shafts of a colliery are 40 degrees Fahr. and 70 degrees Fahr. respectively. What is the volume of air in the upcast which amounts to the same in weight as one cubic foot in the downcast ?
26. If 100 cubic inches of air weigh 31 grains troy, under a barometric pressure of 30 inches, what will 100 cubic inches weigh at a higher altitude where the barometer stands at 26 inches without any change of temperature ?

*Practical Mining.*

27. Describe the provisions of the Coal Mines Regulation Act of 1887 with regard to—

(*a*) Reporting accidents;
(*b*) Shaft signals;
(*c*) Manholes.

28. Give a description of the coal, floor, and roof of a seam you are well acquainted with, and describe fully the method of working it, and the advantage of the method as compared with any alternative method.
29. Make a sketch in ink, illustrating your answer to No. 2 question, giving distances between the roads.
30. Referring to Nos. 2 and 3 questions, give, under the several heads of a cost-sheet, the approximate cost of production per ton of coal raised.
31. Make sketches in ink of the timbering you would adopt for sinking a pit of 15 feet diameter through loose ground, and give an estimate of the cost of the prepared timbering for each yard of sinking.
32. Name any "high explosive" with the use of which you have had experience. Explain how it is used, and what advantages are claimed for it.
33. Make sketches in ink of a colliery tram, tub, or corf, giving its principal dimensions, its weight and cost, and state the weight of coal it is designed to carry.
34. If you require a very accurate measurement of the air passing through an underground roadway, what plan would you adopt for arriving at the mean velocity of the current?
35. What are the various causes of accident by falls of roof in stalls or working faces?

*Colliery Plant and Machinery.*

36. State what materials you would consider suitable for foundations or loadings for a large winding engine, and give an estimate of the cost per cubic yard of foundations constructed of such materials, either under ordinary conditions, or in the case of any work you have been connected with.
37. Compare the relative merits of the Cornish and Lancashire types of steam boilers.
38. Give a full list of the mountings and fittings you would specify for a first-class Lancashire boiler to work at a pressure of 70 lb. per square inch.
39. If you had to set the eccentric and slide valve of an ordinary engine in their right positions, explain how you would do it.
40. Make an ink sketch of an equilibrium or double-beat valve.

41. A fan engine works at the rate of 80 revolutions per minute. The cylinder is 18 inches diameter. The stroke is 30 inches. The mean steam pressure on the piston is 40 lb. per square inch. Work out the theoretical horse-power of this single-cylinder engine.
42. Sketch in ink a good form of foot valve for a pump, and explain its use.
43. If you had to provide an engine to pump 8,000 gallons of water per hour up a vertical shaft which was 150 yards deep, what horse-power would you think it necessary for the engine to be capable of developing in regular work?
44. What are the advantages and disadvantages of employing compressed air on a large scale as a means of obtaining power in mines?
45. Describe and give ink sketches of a good pit cage, and explain how the bridle chains are arranged and connected.

South-Western District (2nd Class), 1893.

*Arithmetic.*

1. How much are the total earnings of five men and the share of each under the following circumstances:—

| | | | | | |
|---|---|---|---|---|---|
| 1st | man, | 4 | days at | 4s. 6d. | per day. |
| 2nd | ,, | $5\frac{3}{4}$ | ,, | 5s. 0d. | ,, |
| 3rd | ,, | 6 | ,, | 4s. 3d. | ,, |
| 4th | ,, | $2\frac{1}{4}$ | ,, | 4s. 2d. | ,, |
| 5th | ,, | $3\frac{1}{2}$ | ,, | 3s. 11d. | ,, |

2. The amount of wages required to pay a company of miners at the standard rate is £15 10s. How much will be required to pay them after an advance of $27\frac{1}{2}$ per cent. upon the standard?
3. If a man gets £2 4s. for getting and filling 24 tons of coal, and pays out 5d. per ton for filling, how much per ton does he receive for getting?
4. How many 9-feet lengths of rails are required to lay a tramway 270 yards long?
5. A tank is 3 feet square by 3 feet deep. How many lb. of water will it contain?

*Gases and Ventilation.*

6. What are the most dangerous gases met with in collieries? Why are they dangerous? Which have you had most experience with?
7. Explain your views as to what effect a heavy fall of the barometer has upon the condition of a mine.

8. How would you measure the velocity of an air current in an air course ?
9. What would you do to examine a working place in which you expect to find carbonic acid gas ?
10. What size air-way would be required to pass 10,000 cubic feet of air per minute at a velocity of 4 feet per second ?

*Practical Mining.*

11. What are the responsibilities and duties of an under-manager in the absence of the manager ?
12. What are the requirements of the Act as to ventilation ?
13. What steps should an under-manager take regarding a collier who neglects to sprag his coal ?
14. What methods should be attended to in order to secure safety in a sinking shaft ?
15. How would you deal with shots which have missed fire ?
16. Describe the methods and precautions you would adopt to drive a road through a heavy fall of roof.
17. Under what circumstances are cogs useful underground ?
18. What signs are there in the face of coal when approaching old workings or goaves ?
19. How would you erect safety doors or reserve doors for immediate use in case of an explosion ?
20. If a collier has been badly injured internally but not killed, what method would you use to ensure the best means to save the life of that person ?

---

MANCHESTER (1ST CLASS), 1902.

*Arithmetic.*

1. Work out, by fractions, the cubical contents of a coal tub, 2 feet 6 inches long, 2 feet 8 inches wide, and 2 feet 4 inches deep.
2. In a system of working, roads are driven every 6 yards apart, 8 feet wide; cut-throughs are driven every 24 yards, 8 feet wide. What are the percentages of coal got and left ?
3. A colliery reservoir is 340 yards long, and 125 yards wide, as measured on the surface. It is 9 feet deep at one end and 10 feet deep at the other end. The slope of the sides is one to one, taking the average width. How many gallons of water will it contain when it is full ?

*Coal Mines Regulation Acts.*

1. State the General Rule and Special Rules of this district for timbering.

2. What are the provisions of the Acts 1887 and 1896 respecting the use of safety-lamps? Say how these are amplified by the new Special Rules of May 28, 1902.
3. A tunnel, which is used as a haulage road and also for the main return air-way, and which is dry and dusty, requires to be enlarged. When should the shots be fired? Give in your own words the rules applying here. What explosive would you use, and why?
4. What are the restrictions as to the employment underground and on the surface of boys under the Coal Mines Regulation Acts, 1887 and 1896?
5. What are the requirements of the Acts 1887 and 1896 regarding the opening up and the abandonment of mines?
6. State fully what the Coal Mines Regulation Acts and the Special Rules say about inspections by workmen, and also state briefly the rules specially applying to a collier in his working place.

*Practical Mechanics.*

1. Describe the action of Hurd's and Gillott and Copley's coal-cutters, and explain what are the most favourable and unfavourable conditions of a mine for working the same.
2. Calculate the size of a pair of winding engines, and give dimensions of drum, ropes, pulleys, &c., suitable for raising 1,200 tons of coal per day from a depth of 450 yards. Time occupied in winding, eight hours. Steam pressure at boiler, 80 lb.
3. You have a double-acting pump, $6\frac{1}{2}$ inch piston, 4 feet 6 inches stroke, working fourteen strokes per minute. Depth 250 yards to bottom of shaft. How many gallons of water will be pumped per minute? What will be the engine power required, taking useful effect at 60 per cent., and what thickness will the rising main (cast iron) be at shaft bottom if it is $9\frac{1}{2}$ inches diameter?
4. State the principal objects to be aimed at in setting steam boilers. Show by sketch, giving dimensions and the arrangement of flues, for a Lancashire boiler 30 feet long and 8 feet diameter. Also show by sketch how you would connect a range of boilers to the main steam pipes.
5. Describe an arrangement of electric shaft signals, giving any special precautions you would take in fitting up the same. Also explain the terms, insulators and conductors. Name some, with their "relative resistance."

*Practical Working.*

1. What are the methods usually adopted to preserve tubbing in upcast shafts? Also give the rule for finding the thickness of metal tubbing.
2. A downcast pit, where 800 tons per day are wound from a seam of coal dipping 1 in 3, is 350 yards; it is required to sink the pit another 100 yards. Describe how you would proceed so as not to interfere with the coal winding operations and sinking to be carried on during the whole twenty-four hours.
3. In sinking a 16 feet circular shaft, the New Red Sandstone is met with at 50 yards deep, with a large feeder of water which eventually reaches 160,000 gallons per hour. The water-bearing strata are passed through at 150 yards deep. Describe shortly, with sketches, how you would proceed with the sinking, ventilating, securing of shaft, and deal with the water.
4. Mention briefly the method you would adopt to secure accuracy when plotting workings on the plan of a mine on which are shown workings closed twenty years previously.
5. What is the area of a block of coal 324 yards by 150 yards, and what is the cubical contents if the seam is 2 feet 3 inches thick, exclusive of dirt; and how many tons will it produce at a specific gravity of 1·25, allowing 5 per cent. for waste, &c.?
6. The full dip (1 in $3\frac{1}{2}$) of a mine has a bearing of $27\frac{1}{2}$ S.W. What is the bearing of a road rising 1 in 12?

*Mine Gases, Lighting, and Ventilation.*

1. Describe the following instruments and their respective uses in a mine:—Barometer, hygrometer, anemometer, and water-gauge.
2. What are the principal gases met with in mines? What are their effects on safety-lamps, life, and general working in a colliery, and state the result of the various mixtures with air.
3. Sketch, with dimensions, and describe fully one of the following fans:—(*a*) Capell, (*b*) Waddle, (*c*) Walker. If you doubled the speed of the fan, what effect would this have on the quantity of air passing in a mine and on your coal consumption?
4. Describe and show a sketch of the Clowes hydrogen gas detector, and any other lamp you are acquainted with; and state what is the smallest amount of gas that can be detected by each?

5. Show how you would ventilate the workings on the annexed plan, having due regard to the requirements for haulage and working of the mine with regard to the restrictions of the Coal Mines Regulation Acts. [Plan not reproduced].

Oral examination, 30; total number of marks, 282; two-thirds of the total number of marks are required for a pass, 188.

---

Manchester (2nd Class), 1902.

1. How many tons of coal are there in a block of coal measuring 5 yards 2 feet 7 inches in length, 3 yards 1 foot 11 inches in breadth, and 3 feet 9 inches thick—the specific gravity being 1·27?
2. What would be the cost of supporting a road 500 yards long with iron bars 9 feet long, set at the rate of three in two yards, and weighing 22 lb. per yard, costing £7 per ton?
3. An equal number of tubs from two mines are raised at one shaft. In mine A the average dirt picked out of each tub is 14½ lb., in mine B 16¾ lb., and the weight contained in each tub, including coal and dirt, is 5¾ cwt. What is the net weight of coal from each mine raised in nine hours if six tubs are wound and decked in one minute and five seconds?

*Coal Mines Regulation Acts.*

1. State the number of books and registers that have to be kept in accordance with the Coal Mines Regulation Acts.
2. What are the duties under the New Special Rules as to timbering for the following persons:—The manager, the fireman, and the miner?
3. What precautions must be taken before and after firing a shot in a sinking pit?
4. State the object of the Special Rules. What is the course to be taken in making the same?
5. State the requirements of the Coal Mines Regulation Acts with regard to boilers.

*Practical Working.*

1. State your opinion which is the best method of working a thick mine or a thin mine, and why.
2. In a sinking pit, how would you be guided where to lay a walling ring? What precautions would you take when sinking below, and also when the walling from the length below had to be joined up to the ring above? Give sketch to illustrate your answers.

3. You have a seam as under :—

| | Ft. | In. |
|---|---|---|
| Rock (strong) | | |
| Wet and broken metal .. .. | 2 | 0 |
| Good coal .. .. .. .. | 1 | 8 |
| Dirt .. .. .. .. .. | 1 | 3 |
| Good coal .. .. .. .. | 2 | 4 |

Show by sketches, with dimensions, how you would work it. The mine dips 1 in 4½ to the south-west.

4. If a fault is met with in driving a level which throws all the coal out, what would guide you as to whether it was an upthrow or downthrow ? If uncertain, how would you proceed ?
5. Describe and show by sketches how you would fix metal tubbing and a water ring in a sinking pit 16 feet diameter.

*Mine Gases, Lighting, and Ventilation.*

1. How many square feet of rubbing surface are there in a circular shaft 18 feet in diameter and 250 fathoms deep ?
2. What arrangement would you make at the pit top of an upcast shaft where you are winding coal ventilated by a fan (exhausting) ?
3. Describe fully, with sketches, the barometer. If the atmosphere were of equal density, what height would it reach under ordinary conditions ?
4. What are the principal gases met with in mines, and what is their effect on safety-lamps, life, and general working of a colliery ?
5. Show how you would ventilate the workings on the annexed plan, having due regard for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Act ? [Plan not reproduced].

Oral examination, 30 ; total marks, 201 ; two-thirds of the total number of marks are required for a pass, 134.

---

MANCHESTER (1ST CLASS), 1901.

*Arithmetic.*

1. How many cubic feet of rock will have to be extracted from a tunnel 100 yards long to make room for a circular arch 6 feet diameter inside, the brickwork being 15 inches thick ?
2. What is the square root of 468·644 correct to three places of decimals ?
3. What will be the length of the side of a square field, in yards, to two places of decimals containing 20 acres

2 roods 2 poles and 20 square yards ? If a seam of coal 3 feet 6 inches thick underlay the field, how many tons of coal would there be in it, the specific gravity of the coal being 1·25 ?

*Coal Mines Acts, Special Rules, and the Explosives Order.*

1. Quote General Rules 1, 2, and 3 as to ventilation. State if General Rule 1 would be affected by holidays and Sundays, and when there was no one in the mine.
2. What are the principal rules colliers have to observe under the Coal Mines Regulation Acts, and the Special Rules in regard to the timbering of their working places ?
3. Quote in your own words the general principle of the Explosives in Coal Mines Order, of October 1st, 1901. What, if any, difference is there from the one issued on September 24th, 1900 ?
4. State the General and Special Rules to be observed with regard to boilers, their fittings, and attendant.
5. What are the inspections required to be made by a fireman before and during each shift ? Give your opinion of the difference between the 1887 and 1896 Acts with regard to such inspections.
6. State fully the requirements of the Act as to the books and registers to be kept at the mine, and those persons who specially have to be appointed in writing.

*Practical Mechanics.*

1. What size hauling engines would be required to haul 100 tons of coal per hour, by direct haulage, up an incline 1,000 yards long, rising 1 in 6, effective steam pressure being 50 lb. per square inch ? Assume your own dimensions of tubs, ropes, &c.
2. To what uses is electricity applied in a coal mine ? Describe shortly the construction of an electrically-driven pump, and also of hauling machine.
3. A three-throw double-acting piston pump, diameter of working barrel being 7 inches and length of stroke 2 feet 6 inches running 9 revolutions per minute, is used to raise water from dip workings a vertical height of 125 yards, the dip of the mine being 1 in 5; the feeder is pumped in eight hours, what is the feeder per minute ? What will be the horse-power required to do the work ?
4. What fittings, other than those required by the Coal Mines Regulation Acts, do you consider necessary for a 30 feet Lancashire boiler ? In fixing a Lancashire boiler, would

you set it level or not? In letting off a boiler, what special precautions would you take?

5. In laying down an electrical plant, what special precautions are to be taken so as to provide for the greatest efficiency, and also safety? What are the names of the four electrical units (or terms) in common use, and explain their meaning? What do you consider a commercial and safe voltage to use for power?

*Practical Working.*

1. Describe by sketch an elevation and cross section of a cast iron tubbing, and state the method of fixing the same, and laying a metal crib in a shaft. Give the rule for finding the thickness.
2. Describe, with sketches, how you would proceed to enlarge a downcast shaft, 200 yards deep, from 8 feet diameter to 12 feet diameter, so as not to interfere with the coal winding in the daytime, and assuming there is no quicksand to deal with.
3. In a pit 90 yards deep, in which 18 inches pump trees are continuous from the bottom to the top, made of cast iron, and in 9 feet lengths, one of the bottom lengths burst, exposing a rent 2 feet long; how would you repair it temporarily, and how would you proceed to replace it with a new one, if your capstan engine was not strong enough to raise the weight?
4. Describe, with sketches, how you would proceed to clear away a heavy fall with a rotten roof, and the best form of timber settings to put in, supposing there was also side pressure.
5. In a bore-hole at "A" coal is found at a depth of 50 yards; 30 degrees north-east and 500 yards away from "A" another bore-hole, "B," finds the coal at 60 yards; 30 degrees south-east, and 500 yards from "B," the coal is 70 yards deep, at "C"; required direction of water-level and direction and rate of full dip.
6. The bearing of a roadway is north-east 30 degrees, what will be the bearing of a cross road going 48 degrees to the north of this?

*Mine Gases, Lighting, and Ventilation.*

1. State in your own words the names and effects of the various gases generally found in coal mines.
2. A downcast and upcast shaft are each 12 feet diameter, and 300 feet deep; the temperature in the former is 60 degrees Fahrenheit and in the latter 150 degrees Fahren-

heit. What would be the motive column in feet? What would the water-gauge be at the bottom?

3. Explain the construction of the following lamps:—Protector, Pieler, Hepplewhite Gray, Marsaut, Mueseler. Say which you prefer, and why.
4. 40,000 cubic feet of air per minute are passing through an air-way 10 feet by 6 feet, with a water-gauge of 0·75 inches. What will be the water-gauge if the same quantity be passed through an air-way 5 feet by 6 feet?
5. Show how you would ventilate the workings on the annexed plan, having due regard to the requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Acts. [Plan not reproduced].

---

Manchester (2nd Class), 1901.

*Arithmetic.*

1. The area of a block of coal is 5,760 square yards, what is the area in acres, roods, perches, and yards? (Statute measure.) What weight of coal is there in the block, the seam being 3 feet 3 inches thick, and weighing 18 cwt. to the cubic yard?
2. If a collier and his drawer get 4 tons of coal for which he is paid 3s. 6½d. per ton, and he pays his drawer 30 per cent. of what he received, how much will he have left for himself?
3. If two pits are winding respectively, No. 1 pit, 1,273 tons 10 cwt. per day, and No. 2 pit, 729 tons 10 cwt. per day, the cost per ton at No. 1 pit being 4s. 1½d., and at No. 2 pit 6s. 1d. per ton, what will be the average cost per ton, taking the two pits together?

*Coal Mines Acts, Special Rules, and the Explosives Order.*

1. State the provisions for persons working machinery underground and on the surface. State the time children may be employed above and below ground per day and per week under the Coal Mines Regulation Acts.
2. What are the duties of an under-manager as described by the General and Special Rules?
3. What are the conditions now laid down with regard to shot-firing in mines, having in view the conditions as published in the Explosives in Coal Mines Order of October 1st, 1901?
4. What are the General and Special Rules to be observed by sinkers?

5. In mines where safety-lamps are in use, what are the precautions to be observed by the workmen in regard to their use ?

*Practical Working.*

1. What system of coal working have you been accustomed to ? Describe same with sketches, and also the system of timbering.
2. Describe the working of compound hauling engines, and explain their advantages and disadvantages over other engines.
3. If you are working packs in a seam of coal 6 feet thick, with a strong roof, what is most essential that the officials should pay particular attention to ? Give the reasons for your answer.
4. State the conditions which may tend to bring about a boiler explosion.
5. When withdrawing timber, what precautions would you take, (*a*) when loosening the timber, (*b*) when removing it from the fall ? What tools do you consider necessary for this work ?

*Mine Gases, Lighting, and Ventilation.*

1. Which in your opinion is the best safety-lamp ? Describe it, with three others you are acquainted with. Give the reasons for your opinion.
2. If the ventilating fan was damaged or the furnace put out by an explosion, and you found the returns full of fire-damp, what temporary means would you adopt to restore the ventilation ?
3. In a mine giving off a large quantity of fire-damp, how would you ascertain if the mine was properly ventilated ?
4. If 10,000 cubic feet of air are circulating through a mine, and you want to increase it to 20,000 cubic feet, how much must the ventilating pressure be increased ?
5. Show how you would ventilate the workings on the annexed plan, having due regard to requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Act. [Plan not reproduced].

---

MANCHESTER (1ST CLASS), 1900.

*Arithmetic.*

1. A single-acting pump, 12 inches diameter and 2 feet stroke, works eight strokes per minute. How many gallons of water are pumped per minute ? One gallon = 277·274 cubic inches.

2. If a tub holds 8 cwt. of dry coals and 8 cwt. 0 qr. 11 lb. of wet coals, what is the percentage of gain to the miner when the coals are wet? Supposing he is paid 5d. for each tub of standard weight, how much does he gain per score of twenty-one tubs?
3. What will be the cost of laying a single tram road 500 yards long with rails 20 lb. to the yard? The rails cost £9 5s. per ton, sleepers 3d. each—laid every yard, 3 cwt. of nebs at 16s. per cwt., and the men are paid 2½d. per lineal yard for laying.

*Coal Mines Acts, Special Rules, and the Explosives Order.*

1. What are the provisions of the Coal Mines Regulation Act with regard to the inspections of machinery—(*a*) On the surface; (*b*) in shafts; (*c*) underground?
2. What is the method of procedure in firing shots in a sinking pit? What precautions must be taken before the shots are fired and after firing before work is resumed?
3. What is the principal point in which the Explosives in Coal Mines Order of September 24, 1900, differs from the former ones? What is your view of its practical effect?
4. State the requirements of the Coal Mines Regulation Act with respect to accidents met with in mines upon the following matters:—(1) Reporting; (2) inspector's visit; (3) attendance at inquests; (4) inspection of place where accident took place.
5. State shortly the duties of an under-manager as defined by the Act and the Special Rules of the district.
6. What are the requirements of the General and Special Rules with regard to timbering, and the supply of the same?

*Practical Mechanics.*

1. What is the horse-power of a steam engine which is capable of hauling a train of twelve tubs of coal by a single rope up an incline 600 yards long with a dip of 1 in 4 in four minutes? The tubs weigh 4 cwt. and carry 7 cwt. of coal. Allowance must be made for the weight of the rope and all friction.

   If a pair of engines geared 3 to 1 with a drum 5 feet diameter are employed to do this work, what will be the diameter of the cylinders and length of the stroke, the steam pressure being 60 lb. per square inch at the boilers?

2. The safety valve on a steam boiler is 2½ inches diameter; the lever is 30 inches long and 4 inches from the valve to the fulcrum. If the weight on the end of the lever is 45 lb. and neglecting the weight of the lever, what will be the steam pressure per square inch when the valve is on the point of blowing off?
3. In a shaft 300 yards deep there is a column of cast iron pipes 12 inches diameter connected to an underground pump. What is the total weight of water contained in the pipes, what is the bursting pressure per square inch upon the lowest pipe, and what thickness will it require to be?
4. What is the approximate difference in the percentage of duty given out at the motor or driven engine between compressed air and electricity, supposing each to be modern and well-designed plants? The horse-power of the steam generating engines being the same in each case. Give details of the different items of loss.

*Practical Working.*

1. Having regard to the great number of accidents from falls of roof and sides which happen in the working faces in coal mines, what, in your opinion, are the precautions necessary to reduce the number of these accidents? Give full details.
2. What should be the proportion between the working load and the breaking strain of a steel wire winding rope? What precautions should be taken in the use of wire ropes as regards their capping, preservation, and examination? What length of time should a rope be in work?
3. What circumstances would guide you in selecting the position for an underground dam for resisting a heavy pressure of water? How would you construct such a dam, and what special precautions would you take during the construction? Give sketches and dimensions, and state the materials to be used, with details of what would be required to make it secure.
4. An upcast pit collapses 100 yards from the surface, and the brickwork falls away for a depth of 30 yards, accompanied by large quantities of the strata, leaving cavities 6 or 7 feet deep, and the brickwork above hanging in a dangerous condition. Describe fully how you would proceed to secure the pit and then brick it up again, and say what kind of scaffold you would use.

5. Sketch on your paper as near as you can the following survey:—

| | | | | | |
|---|---|---|---|---|---|
| A to B | .... | 82 | N.E. | .... | 68 links. |
| B „ C | .... | 51 | S.E. | .... | 95 „ |
| C „ D | .... | 63 | N.E. | .... | 78 „ |
| D „ E | .... | 20 | N.E. | .... | 97 „ |
| E „ F | .... | 35 | N.W. | .... | 87 „ |
| F „ G | .... | 87 | N.W. | .... | 140 „ |
| G „ H | .... | 52 | S.W. | .... | 140 „ |
| H „ I | .... | 48 | S.E. | .... | 85 „ |

6. It is necessary to cross a river in measuring a line of a survey. The river is too wide for a chain to stretch across. A pole can be fixed on the opposite side of the river, but no instrument except poles and a chain are available. How would you ascertain the width of the river so as to continue the survey line?

*Mine Gases, Lighting, and Ventilation.*

1. What do you consider a reasonable or ordinary velocity for air to be passed through a main airway? What is the greatest velocity you consider practicable? What are the disadvantages of a high velocity? What, if any, are the disadvantages of a low velocity in a fiery mine?
2. If a drift, 30 yards long, 6 feet wide, and 4 feet high, was filled with a mixture of fire-damp and air at the most explosive point, what quantity of air would be required to dilute it so as to be non-explosive?
3. Give the properties, symbols, and specific gravities of the following gases, and state how each affects the human body:—(1) Carbon monoxide, (2) carbon dioxide, (3) hydrogen sulphide, (4) fire-damp.
4. If 9,000 cubic feet of air per minute circulate through a regulator, 30 inches by 20 inches, how much will circulate if it is enlarged to 30 inches square, the pressure and rubbing surfaces being the same in both cases?
5. Show how you would ventilate the workings on the annexed plan, having due regard to the requirements for haulage. [Plan not reproduced].

---

Manchester (2nd Class), 1900.

*Arithmetic.*

1. How many cubic feet of air are passing per hour through an air-way 7 feet 6 inches wide and 5 feet high, when the velocity is 8 feet per second? What is the perimeter of the air-way?

2. If a level is driven 7 feet wide, in a seam 4 feet 3 inches thick, what length must be driven in order to get 100 tons, allowing 18 cwt. of coal to a cubic yard ?
3. The field rate of day's wage is 4s. ; if 37½ per cent. is added to this, what would be the total extra earnings of a workman in a year, supposing he worked 300 days ?

*Coal Mines Acts, Special Rules, and the Explosives Order.*

1. Under what circumstances does the Coal Mines Regulation Act require the employment of fences ? Name some other cases in which fences would be advantageous or necessary to safe working.
2. What are the duties of the coal miner with respect to timbering, as defined by the Coal Mines Regulation Act and the Special Rules of the District in those cases where the timbering of the working places is done by the workmen employed therein ? What are the penalties for neglect ?
3. Give the requirements of the Coal Mines Regulation Acts with respect to the inspection of mines both before and during the shifts.
4. State the precautions you would adopt with regard to the safety of detonators both on the surface and in the pit. And also with regard to the reporting of any miss-fired shots, and the means to be adopted to secure safety to the workpersons in the event of miss-fires.
5. Give a list of the report books and registers which are to be kept at a colliery—both surface and underground.

*Practical Working.*

1. What are the principal things to be attended to in order to secure workpersons in a mine against falls of roof and sides ? What rules would you suggest as a guide to the workpersons ?
2. There is a mouthing in a shaft used for drawing coal both from the bottom and from the mouthing. Describe fully the precautions necessary, and the means you would adopt to prevent accidents to persons using the mouthing. Give a full code of the signals you would use.
3. What steps would you use in case of a " miss-shot " (1) in a sinking pit where safety fuse and gunpowder were used ; (2) in a tunnel where electric battery and high explosives were used ; (3) in a coal face where electric battery and high explosive were used ?

4. If the roof in a self-acting brow was so bad that you could not maintain width enough for the ordinary system of having two roads for the tubs to run on, describe such modes of overcoming the difficulty as you are acquainted with.
5. What is the best and most practical way of strengthening air stoppings? Describe same with a sketch. Give also descriptions with sketches of the various air crossings you are acquainted with and state which you consider the best, giving your reason.

*Mine Gases, Lighting, and Ventilation.*

1. Describe the operation of clearing gas out of a working, and state the precautions necessary to be observed whilst doing so.
2. Give the properties, symbols, and specific gravities of the following gases, and state how each affects the human body: (1) Carbon monoxide; (2) hydrogen sulphide; (3) carbon dioxide; (4) fire-damp.
3. What are the advantages of splitting the air-currents in a mine? Are there any disadvantages? If so, describe them.
4. State how you would ascertain the proportion of carburetted hydrogen gas in a working place; or, in other words, describe the appearance of the flame in a safety-lamp for different proportions of gas present.
5. Show how you would ventilate the workings on the annexed plan, having due regard to the requirements of haulage. [Plan not reproduced].

---

MANCHESTER (1ST CLASS), 1892.

*Arithmetic.*

1. Express 8 cwt. 3 qrs. as the decimal of a ton.
2. Divide 1·1214 by 5·34.
3. A block of coal is 1a. 2r. 10p. in area, and 4 feet 3 inches thick. Give weight of coal, reckoning 18 cwt. per cubic yard.

*Practical Mechanics.*

4. A double-acting pumping engine, with ram 7 inches in diameter and 2 feet stroke, is required to pump up a shaft 175 yards in depth, with a steam pressure of 45 lb. per square inch at the engine. What diameter must the steam cylinder be, allowing one-fifth for friction, and what quantity of water will be pumped at 20 revolutions per minute?

5. The weight of coal and rope in a shaft 550 yards deep is 4¼ tons, find H.P. of engine.
6. In putting steam pipes in a shaft how would you prepare for contraction and expansion? Give sketches for 5-inch cast-iron and 2-inch wrought iron pipes.
7. In preparing a self-acting incline, how would you arrange the gradients at top and bottom? Give a sketch of the brake you would adopt.

*Coal Mines Act.*

8. What books does the Act require to be kept?
9. Enumerate all the provisions of the Act with regard to plans.
10. What are the requirements of the Act as to engines and boiler houses underground?
11. What are the provisions of the Act with respect to the dimensions of roadways?

*Practical Working.*

12. What pillar of coal would you leave for the protection of a pumping shaft in a mine 5·5 feet in thickness with a dip of 1 in 3, depth of shaft 450 yards?
13. Make a sketch of a furnace for an extensive mine, marking the dimensions. Under what conditions does danger attend their use in a fiery mine? How would you avoid them?
14. Under what conditions would you use compressed air? What are the advantages and disadvantages of its use?
15. If you were called up in the middle of the night, and found the engine-house (containing the engine. drums, and ropes) on fire, how would you proceed?
16. What are the disadvantages (if any) of using cast-iron tubbing in a furnace shaft, and what would you do to overcome them?
17. State what, in your opinion, are the two most serious classes of accidents in mines. Give your reasons for the same.

*Gases, Lighting, and Ventilation.*

18. What horse-power is spent in the ventilating of a mine when the quantity of air passing is 95.000 cubic feet per minute and the water-gauge 3·75?
19. State the benefits of splitting the air. Where should the splits leave and join so as to obtain the greatest possible effect?
20. After an explosion of fire-damp, what gases result?
21. To what extent will 2,000 volumes of gas expand if the barometer falls from 30·15 inches to 29·30 inches?

2 roods 2 poles and 20 square yards? If a seam of coal 3 feet 6 inches thick underlay the field, how many tons of coal would there be in it, the specific gravity of the coal being 1·25?

*Coal Mines Acts, Special Rules, and the Explosives Order.*

1. Quote General Rules 1, 2, and 3 as to ventilation. State if General Rule 1 would be affected by holidays and Sundays, and when there was no one in the mine.
2. What are the principal rules colliers have to observe under the Coal Mines Regulation Acts, and the Special Rules in regard to the timbering of their working places?
3. Quote in your own words the general principle of the Explosives in Coal Mines Order, of October 1st, 1901. What, if any, difference is there from the one issued on September 24th, 1900?
4. State the General and Special Rules to be observed with regard to boilers, their fittings, and attendant.
5. What are the inspections required to be made by a fireman before and during each shift? Give your opinion of the difference between the 1887 and 1896 Acts with regard to such inspections.
6. State fully the requirements of the Act as to the books and registers to be kept at the mine, and those persons who specially have to be appointed in writing.

*Practical Mechanics.*

1. What size hauling engines would be required to haul 100 tons of coal per hour, by direct haulage, up an incline 1,000 yards long, rising 1 in 6, effective steam pressure being 50 lb. per square inch? Assume your own dimensions of tubs, ropes, &c.
2. To what uses is electricity applied in a coal mine? Describe shortly the construction of an electrically-driven pump, and also of hauling machine.
3. A three-throw double-acting piston pump, diameter of working barrel being 7 inches and length of stroke 2 feet 6 inches running 9 revolutions per minute, is used to raise water from dip workings a vertical height of 125 yards, the dip of the mine being 1 in 5: the feeder is pumped in eight hours, what is the feeder per minute? What will be the horse-power required to do the work?
4. What fittings, other than those required by the Coal Mines Regulation Acts, do you consider necessary for a 30 feet Lancashire boiler? In fixing a Lancashire boiler, would

you set it level or not? In letting off a boiler, what special precautions would you take?

5. In laying down an electrical plant, what special precautions are to be taken so as to provide for the greatest efficiency, and also safety? What are the names of the four electrical units (or terms) in common use, and explain their meaning? What do you consider a commercial and safe voltage to use for power?

*Practical Working.*

1. Describe by sketch an elevation and cross section of a cast iron tubbing, and state the method of fixing the same, and laying a metal crib in a shaft. Give the rule for finding the thickness.
2. Describe, with sketches, how you would proceed to enlarge a downcast shaft, 200 yards deep, from 8 feet diameter to 12 feet diameter, so as not to interfere with the coal winding in the daytime, and assuming there is no quicksand to deal with.
3. In a pit 90 yards deep, in which 18 inches pump trees are continuous from the bottom to the top, made of cast iron, and in 9 feet lengths, one of the bottom lengths burst, exposing a rent 2 feet long; how would you repair it temporarily, and how would you proceed to replace it with a new one, if your capstan engine was not strong enough to raise the weight?
4. Describe, with sketches, how you would proceed to clear away a heavy fall with a rotten roof, and the best form of timber settings to put in, supposing there was also side pressure.
5. In a bore-hole at "A" coal is found at a depth of 50 yards; 30 degrees north-east and 500 yards away from "A" another bore-hole, "B," finds the coal at 60 yards; 30 degrees south-east, and 500 yards from "B," the coal is 70 yards deep, at "C"; required direction of water-level and direction and rate of full dip.
6. The bearing of a roadway is north-east 30 degrees, what will be the bearing of a cross road going 48 degrees to the north of this?

*Mine Gases, Lighting, and Ventilation.*

1. State in your own words the names and effects of the various gases generally found in coal mines.
2. A downcast and upcast shaft are each 12 feet diameter, and 300 feet deep; the temperature in the former is 60 degrees Fahrenheit and in the latter 150 degrees Fahren-

heit. What would be the motive column in feet? What would the water-gauge be at the bottom?

3. Explain the construction of the following lamps:—Protector, Pieler, Hepplewhite Gray, Marsaut, Mueseler. Say which you prefer, and why.
4. 40,000 cubic feet of air per minute are passing through an air-way 10 feet by 6 feet, with a water-gauge of 0·75 inches. What will be the water-gauge if the same quantity be passed through an air-way 5 feet by 6 feet?
5. Show how you would ventilate the workings on the annexed plan, having due regard to the requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Acts. [Plan not reproduced].

---

MANCHESTER (2ND CLASS), 1901.

*Arithmetic.*

1. The area of a block of coal is 5,760 square yards, what is the area in acres, roods, perches, and yards? (Statute measure.) What weight of coal is there in the block, the seam being 3 feet 3 inches thick, and weighing 18 cwt. to the cubic yard?
2. If a collier and his drawer get 4 tons of coal for which he is paid 3s. 6½d. per ton, and he pays his drawer 30 per cent. of what he received, how much will he have left for himself?
3. If two pits are winding respectively, No. 1 pit, 1,273 tons 10 cwt. per day, and No. 2 pit, 729 tons 10 cwt. per day, the cost per ton at No. 1 pit being 4s. 1½d., and at No. 2 pit 6s. 1d. per ton, what will be the average cost per ton, taking the two pits together?

*Coal Mines Acts, Special Rules, and the Explosives Order.*

1. State the provisions for persons working machinery underground and on the surface. State the time children may be employed above and below ground per day and per week under the Coal Mines Regulation Acts.
2. What are the duties of an under-manager as described by the General and Special Rules?
3. What are the conditions now laid down with regard to shot-firing in mines, having in view the conditions as published in the Explosives in Coal Mines Order of October 1st, 1901?
4. What are the General and Special Rules to be observed by sinkers?

5. In mines where safety-lamps are in use, what are the precautions to be observed by the workmen in regard to their use ?

*Practical Working.*

1. What system of coal working have you been accustomed to ? Describe same with sketches, and also the system of timbering.
2. Describe the working of compound hauling engines, and explain their advantages and disadvantages over other engines.
3. If you are working packs in a seam of coal 6 feet thick, with a strong roof, what is most essential that the officials should pay particular attention to ? Give the reasons for your answer.
4. State the conditions which may tend to bring about a boiler explosion.
5. When withdrawing timber, what precautions would you take, (*a*) when loosening the timber, (*b*) when removing it from the fall ? What tools do you consider necessary for this work ?

*Mine Gases, Lighting, and Ventilation.*

1. Which in your opinion is the best safety-lamp ? Describe it, with three others you are acquainted with. Give the reasons for your opinion.
2. If the ventilating fan was damaged or the furnace put out by an explosion, and you found the returns full of fire-damp, what temporary means would you adopt to restore the ventilation ?
3. In a mine giving off a large quantity of fire-damp, how would you ascertain if the mine was properly ventilated ?
4. If 10,000 cubic feet of air are circulating through a mine, and you want to increase it to 20,000 cubic feet, how much must the ventilating pressure be increased ?
5. Show how you would ventilate the workings on the annexed plan, having due regard to requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Act. [Plan not reproduced].

---

MANCHESTER (1ST CLASS), 1900.

*Arithmetic.*

1. A single-acting pump, 12 inches diameter and 2 feet stroke, works eight strokes per minute. How many gallons of water are pumped per minute ? One gallon = 277·274 cubic inches.

ground in one shift? How many splits would you think desirable?

5. Ventilate the annexed plan of a fiery mine ventilated by a fan. Coal is raised at the downcast shaft only. (Plan not reproduced.)

*Principles of Mechanics and Machinery.*

6. A screw-jack has four handles, at the end of which a force of 15 lb. is exerted. What must be the length of each handle for the machine to lift a weight of 8 tons, the pitch of the screw being $\frac{1}{2}$ inch, the friction not to be taken into account?
7. What system of haulage would you adopt to draw 500 tons of coal per day of nine hours up a brow 1,500 yards long, dipping 1 in 7, the pressure of steam available being 60 lb. per square inch? Give dimensions of engines, pulleys, rope, &c. What speed would you run the rope?
8. What inspections have to be made of the engines, boilers, ropes, and chains? Explain in detail how you would inspect ropes and chains.
9. Describe, with sketches, how you would secure iron conducting rods to the headgear of a shaft 500 yards deep. What weight would you put at the bottom of each rod, and how would you secure the weights? What precautions would you take to maintain these in proper working condition? What proportion of its weight does cast iron lose on being submerged in water?
10. What are the chief purposes for which electricity is applied in the working of coal mines? What are the advantages and what the disadvantages in each case?
11. Describe with sketches two kinds of mechanical coal-cutting machines.
12. In fitting up an 18 feet shaft, 600 yards deep, to raise 1,000 tons of coal per day of nine hours with two cages in the shaft, what boilers and size of engines would you erect? Give dimensions of cylinders, drum, head-gear, pulleys, and rope.

*Mine Working.*

13. What are the safety-lamps most commonly used? Describe these, and say what precautions you would take in the cleaning and inspection to ensure safety from ignition of gas whilst in use.
14. Give sketches, with principal dimensions, showing how you would construct an air-crossing to pass 60,000 cubic feet of air per minute.

15. In what parts of a mine are you most likely to find accumulations of coal-dust? Do you consider the presence of coal-dust a source of danger? Give your reasons. What system for dealing with coal-dust are you acquainted with, and what are the advantages or disadvantages of the same?
16. There are two workable seams of coal, one 400 yards and the other 430 yards below the surface. Which seam would you work first? Give reasons for your answer.
17. State the requirements of the Coal Mines Regulation Act as to shot-firing in a fiery mine. What other precautions would you enforce? What is a "missed shot," and what is a "blown-out shot," and how may these be caused? What are the dangers arising from these?
18. How would you construct a dam in a tunnel 10 feet wide by 6 feet high, to withstand a pressure of 150 lb. per square in h? Give details, and say what materials you would use.
19. What are the causes of "gob fires" underground, and what steps would you take on discovering one?

*Timbering.*

20. Describe with sketches the Courrieres system of timbering. What are its advantages and disadvantages?
21. Under what circumstances would you use chocks? How would you fix these, and how would you withdraw them?
22. How would you proceed to clean up a large fall in a main haulage brow? Show by sketch how you would timber the place, and state what special precautions you would take.

*Surveying.*

23. What is "ordnance datum?" What is a "bench mark?" What is a "contour line?" Describe fully the meaning of each of these terms.
24. How do you put the magnetic meridian on a plan? How often would you check this?
25. What are the requirements of the Coal Mines Regulation Act as to plans?

*Shafts.*

26. The side of a shaft, total depth say 400 yards, has given way 200 yards from the surface; there are mouthings at seams lying above and below. Describe fully what steps should be taken to repair the damage.

27. In sinking a 16 feet shaft, what means would you adopt to secure the sides below the last bricking ring where the strata are shale and metal? Give particulars and dimensions of the materials you would use.

28. How would you fit up a winding shaft 600 yards deep with means of signalling? What size of wire would you use, and how would you secure it?

---

Wigan (2nd Class), 1901.

1. What will be the total weight of water in a total column of pipes 10 inches diameter, 150 yards deep? And what will be the pressure per square inch at the bottom?

2. How often would you examine the pump rods of a bucket or lift pump, and how would you do it? If such a pump gave over delivering water, what would you think was the cause and how would you remedy it? How far would you place the working barrel above the water in the lodge?

3. When a fireman goes his rounds of inspection, what are the chief points he should direct his attention to?

4. What precautions should be taken in reference to underground engine-houses and boiler-houses?

5. What books have to be kept at a mine to comply with the requirements of the Coal Mines Regulation Act? What is the duty of the under-manager with reference to the same?

6. How may an explosion of coal-dust be occasioned in a mine?

7. In a mine where the drawing roads are rather steep, do you prefer tubs with wheels loose on the axles or fast? Give your reasons.

8. What explosive do you prefer for use in a fiery mine? What special precautions would you take in addition to the requirements of the Coal Mines Regulation Act to prevent accidents from shot-firing?

9. Show by a sketch the method of working coal you are best acquainted with. Give position of props, bars, and other timber you should use. What does the Coal Mines Regulation Act say as to the setting of timber?

10. How often would you examine the weights at the bottom of iron conducting rods in a pit shaft, and what points would you specially notice?

## WIGAN (1ST CLASS), 1892.

*Elementary Education and Ventilation.*

1. You have 120,000 cubic feet of air per minute passing into a mine at a temperature of 45 degrees F., the temperature of the return at the bottom of the upcast being 82 degrees F. What is the volume of air circulating in the upcast per minute? Show calculation.
2. With furnace and fan ventilation state where, in each case, you will find the highest and lowest water-gauge in the whole course of the ventilating current.
3. What shape of air-way gives the best results—
   (*a*) As to economy in construction;
   (*b*) As to friction?
4. What are the principal points to be observed in the management of a fiery mine to comply with the Coal Mines Regulation Act?
5. Mark the ventilation on the annexed plan of a fiery seam ventilated by means of a fan. [Plan not reproduced].

*Principles of Mechanics and Machinery.*

6. What is the normal strain on a hauling rope on both sides of the main driving pulley under the following conditions:—Endless rope, engine on surface shaft 150 yards deep; one down brow 1,350 yards long, average dip 1 in 12, from which 50 tons of coal per hour are hauled in tubs weighing 3 cwt. each and holding 6 cwt. of coal; the diameter of the rope being 1 inch?
7. What type of pump would you adopt to raise 300 gallons per minute up a shaft 180 yards deep? Give dimensions and rough sketch of main parts of engine and pump.
8. Given a lever of 7 feet long, weighted with 45 lb. at one end and 35 lb. at the other, where would the fulcrum have to be placed so that the lever would be balanced?
9. What sort and weight of tram rails do you consider best for underground use where the loaded tubs weigh 10 cwt.?
10. In putting a range of 6-inch steam pipes in a shaft 300 yards deep, what would you guard against and how would you do it?
11. Describe the relative advantages and disadvantages of round and flat steel winding ropes.
12. What does the Coal Mines Regulation Act require as to—
   (*a*) Winding drums;
   (*b*) Fittings of a steam boiler?

*Mine Working.*

13. Having two workable mines within 25 yards of each other, which would you advise working first with a view to safety and economy? What special precautions would you take if both mines were of a fiery character?
14. What are the requirements of the Coal Mines Regulation Act as to signalling in—
    (*a*) Shafts;
    (*b*) Engine planes?
    Describe a system of electric signalling.
15. Upon what system would you work a mine liable to spontaneous combustion, and how would you deal with a gob fire in such a mine?
16. What are the principal duties of a fireman? How often and when have inspections to be made of roadways and working places?
17. In approaching an old goaf, the exact position and contents of which are unknown, what precautions would you take?
18. What, in your opinion, is the best way of avoiding the risk of a "dust explosion" underground?
19. Describe and give a sketch of a dam to be put in a tunnel 8 feet by 5 feet to withstand a pressure of 200 lb. per square inch.

*Timbering.*

20. State the method by which you would permanently secure the pit eye of an important winding shaft 16 feet diameter, where you expect to raise 600 tons a day, hooking on at both sides of the shaft, the roof and warrant of the mine being of a treacherous nature.
21. Describe, by a sketch, how you would set sprags in a mine 4 feet thick working long wall up brow, rising 1 in 5, where the holing dirt is 18 inches thick and the bottom floor soft. What distance apart should the sprags be set?
22. What sort and thickness of bar timber would you use for a roadway 12 feet wide by 6 feet high in a mine with a bad roof 600 yards deep from the surface? Give a sketch of the way you would set the bars.

*Surveying.*

23. You have to drive a tunnel for a waterway to meet midway between two shafts, and have no reliable plan. How would you proceed?
24. State what is necessary to observe with regard to colliery plans.

25. What instrument would you use for a very important underground survey? State what precautions you would take to secure the accuracy of your work.

*Shafts.*

26. Describe and sketch the best arrangement for hooking on coal in a shaft at a mine half-way down to the main seam, where two cages are used, running on iron-weighted conductors.

27. What are the special difficulties to be arranged for in the sinking of a shaft in entirely new ground? State how you would proceed at the commencement.

28. Describe by a sketch how you would secure a range of 12-inch cast-iron water pipes in a shaft 15 feet diameter and 300 yards deep. Give sizes of timber or other materials used.

---

WIGAN (2ND CLASS), 1892.

1. If 20,000 cubic feet of air per minute are passing in an air-way 10 feet wide by 5 feet 6 inches high, what is the velocity in feet per second?

2. In what velocity per second of an explosive mixture do you consider it safe to carry an unprotected lighted Davy lamp?

3. Describe the safety-lamp you consider safest to use in a fiery mine.

4. Under what conditions would you withdraw a man from his working place?

5. If a cage weighs 2 tons 5 cwt., the rope and chains 25 cwt. 3 qrs., and six loaded tubs 7 cwt. 2 qrs. each, what is the total weight of the load when the cage is at the bottom of the shaft?

6. In holing the coal across the face of a ribbing place 5 yards wide, how many sprags would you set?

7. What do you know about fire-damp, and how does it differ from black-damp?

8. Show, by a sketch, how you would direct the air-current in six places, working wide work, where two of them are fallen up at the face. Mark the cross road and drawing roads on.

9. What special points must a shot-lighter attend to?

Newcastle (1st and 2nd Class), 1902.

*Arithmetic.*

1. It is desired to drain a dozen bords, each 33 yards in length by 5 yards wide and 3 feet 6 inches high. They are full of water, and a feeder of 37 gallons per minute is in communication with them. How many days will it take to do this with a pump lifting 116 gallons per minute? Answer to three places of decimals.
2. How many fire-clay lumps moulded to the curve of the shaft, each lump $7\frac{1}{2}$ inches high, and $15\frac{1}{2}$ inches long, on the inside of the curve, will be required to line a shaft 14 feet diameter inside and 50 fathoms deep, the thickness of each joint being $\frac{1}{2}$ inch?
3. How many tons of coal at 1,500 tons per foot per acre will be yielded from each of two seams, one 2 feet 7 inches thick and the other 4 feet 2 inches thick, in a royalty containing 1,716 acres?
4. A cylinder 26 feet high has a volume of 87,938 cubic feet. What is its diameter in feet to two places of decimals?
5. Add:

| Acres. | R. | P. |
|---|---|---|
| 236 | 1 | 16 |
| 871 | 1 | 17 |
| 392 | 3 | 14 |
| 668 | 2 | 23 |
| 23 | 1 | 18 |
| 741 | 3 | 9 |
| 632 | 0 | 27 |
| 889 | 2 | 30 |

6. The output of a mine is:

| | Tons. | Cwt. |
|---|---|---|
| Best coal ..... | 4,895 | 6 |
| Unscreened ..... | 1,763 | 3 |
| Small ..... | 2,107 | 14 |
| Stones, brasses, &c. ..... | 216 | 8 |
| Waste ..... | 27 | 13 |
| Total ..... | 9,010 | 4 |

What is the percentage of each to two places of decimals?

*Coal Mines Regulation Acts.*

1. In what circumstances can a mine be exempted from the provisions of the Act relating to the payment of the workmen by the weight of the mineral gotten?

2. Quote General Rule 16 relating to keeping refuge holes clear. What is the object of this rule ?
3. Give in as few words as possible a list of the requirements in the General Rules for the prevention of accidents whilst lowering or raising persons in the shaft of a mine.

*Engineering.*

1. Describe a method of attaching a round winding rope to the drum of the winding engine; and also to the cage chains. Illustrate your answer with sketches.
2. If a pitch-pine balk 6 inches broad by 9 inches deep, and spanning an opening 10 feet in width, will support a load at its centre of 8 tons, what load will a similar balk support, spanning an opening of 12 feet ?
3. What is the horse-power of an engine with one cylinder 16 inches diameter by 3 feet stroke, when making 23 revolutions per minute, with a mean effective steam pressure of 57 lb. ?

*Practical Mining.*

1. Describe the duties of the fore-shift deputy where safety-lamps are used.
2. Show by plan how the workings of a colliery are ventilated.
3. Discuss the relative advantages of the bord and pillar and long wall methods of working.

*Gases and Lighting.*

1. What are the composition and character of fire-damp and stythe ?
2. Describe any safety-lamp with which you may be acquainted, and illustrate your description with a sketch.
3. What steps would you take to restore a person overcome by poisonous gases ?

---

NEWCASTLE (1ST CLASS), 1902.

*Gases and Ventilation.*

1. A fan 30 feet diameter is observed to deliver 55,000 cubic feet per minute at 36 revolutions, with a water-gauge of 1 inch. What is the horse-power in the air, and what is the efficiency, the indicated horse-power of the engine driving it being 12½ ? Also, how many cubic feet per minute would the fan deliver if the speed was increased to 45 revolutions per minute, and what then would be the indicated horse-power of the engine ?
2. What is meant by the term "splitting the air ?" What are the advantages of splitting the air; can it be carried too far ? If so, state the reason why.

3. Describe and sketch a water-gauge, a barometer, a regulator for an air-way, and an anemometer. State what they are used for in mines.

*Practical Mining.*

1. How would you make a stopping and an air-crossing upon a main road so as to resist an explosion ?
2. How would you lay out underground a new seam 100 fathoms from the surface and 3 feet thick, with a good roof and dipping to the east about 1½ inches per yard, to be worked with coal-cutters ? There is a good deal of gas and water, and the shafts are near the centre of the royalty, output 800 tons per day. The coal works best when face advancing to the north or to the south. Illustrate your answer with sketches.
3. Describe the process of sinking and walling a pit—finished size 14 feet diameter—from the surface to the stone-head, a depth of 10 fathoms. There is very little water.

*Surveying.*

1. What is the variation of the needle for this year at Greenwich and at Newcastle ?
2. Plot the following survey :—

| | Links. |
|---|---|
| No. 1.—N. ..... | 210 |
| „ 2.—N. 2 W. ..... | 265 |
| „ 3.—N. 5 E. ..... | 197 |
| „ 4.—N. 78 E. ..... | 615 |
| „ 5.—S. 3 W. ..... | 377 |
| „ 6.—S. 85 W. ..... | 159 |
| „ 7.—S. 2 E. ..... | 180 |
| „ 8.—S. 4 W. ..... | 219 |
| „ 9.—N. 87 W. ..... | 307 |
| „ 10.— ? ..... | ? |

And state the last bearing and distance to tie into No. 1.

3. How would you show the variation in level of the workings upon a colliery plan ?

*Engineering.*

1. It is proposed to drain a mine 100 fathoms deep, having a feeder of 300 gallons per minute, by means of a single-cylinder high-pressure engine and double-acting ram. The pressure of the steam upon the gauge at the engine is 70 lb. What diameter and stroke would you advise for the engine and for the ram ; and what diameter for the suction pipes and rising main, assuming that the feeder has to be dealt with in a shift of eight hours ?

2. What are the chief points to be considered in laying out boilers and engines at a colliery for working with an economical consumption of fuel ?
3. What are the advantages and disadvantages of employing compressed air as compared with electricity underground ?

*Legislation.*

1. Quote the three new Special Rules relating to timbering in mines, but not necessarily in the exact words of the rules ; and give your views upon each of them.
2. Quote General Rule 4 relating to examination before commencing work, but not necessarily in the exact words of the rule. Does there appear to you to be anything a little indefinite in this rule, and, if so, what ?
3. Quote General Rule 36, as to observance of directions.

---

NEWCASTLE (1ST AND 2ND CLASS), 1901.

*Arithmetic.*

1. Add :

| Tons. | cwt. | qrs. | lb. | oz. |
|---|---|---|---|---|
| 14 | 13 | 3 | 10 | 7 |
| 179 | 5 | 2 | 12 | 6 |
| 63 | 16 | 2 | 27 | 13 |
| 18 | 19 | 3 | 13 | 12 |
| 142 | 4 | 1 | 18 | 8 |
| 983 | 7 | 1 | 23 | 9 |
| 661 | 17 | 3 | 4 | 11 |
| 271 | 6 | 2 | 19 | 7 |

2. Subtract : 48,765 acres 3 roods 33 perches from 67,857 acres 2 roods 29 perches.
3. Divide a vend of 387,417 tons between three lessors, A, B, and C, according to their respective drawings, as follows :— A, 214,216 tons ; B, 149,382 tons ; C, 62,560 tons.
4. Extract the square root of 67,352·6 to two places of decimals.
5. Taking 5s. 2d. as the standard wage for hewers, and wages at 38¾ per cent. above standard, what is the hewer's wage ?
6. Which is the greater, $\frac{2}{5}$ or $\frac{3}{8}$, and by what percentage ?

*Coal Mines Regulation Acts.*

1. What are the provisions of the Mines Acts, 16 (1) *a*, *b*, *c*, relating to single shafts ? and what in your opinion are the reasons for these provisions ?

2. Quote General Rule 13 relating to bore-holes. What is the object of this rule?
3. Quote General Rule 26 relating to overwinding.

*Engineering.*

1. What do you consider should be the factor of safety for winding ropes, and what sized round steel wire (tensile strength of wire 100 to 110 tons to the square inch) winding rope would you advise for a working load of six tons?
2. Describe the action of a cow-tailed pump, suitable for use underground, and illustrate your description with sketches.
3. How would you change a hauling rope in the following circumstances? Five hundred yards of the tail rope next the drum have to be replaced by a similar length of new rope. The tail rope is carried by sheaves supported by hangers from the roof.

*Practical Mining.*

1. Describe the method of working coal by long wall, and by any other system with which you are acquainted. Make a plan of a district upon each system to a scale of about 25 inches to the mile, capable of stowing twenty men in each shift. Also show the direction of air currents, and the position of all stoppings, crossings, regulators, doors, and sidings.
2. Make two suggestions for dealing with a feeder of 50 gallons per minute, in a staple that is being sunk down over a depth of 10 fathoms, in dip workings 1,000 yards inbye.
3. What is the commercial character of Wallsend coal, from what seam was it originally produced, and from what does Wallsend derive its name?

*Gases and Lighting.*

1. What do you consider to be the best form of safety-lamp? Describe it, and sketch the reasons for your approval.
2. Of what material should prickers and stemmers be made, and why?
3. State objections to the use of gunpowder in mines, and describe three substitutes, giving reasons for and against the use of each.

*Gases and Ventilation.*

1. What are your views as to the establishment of colliery rescue stations at convenient centres; and what apparatus has it been suggested should be kept at them?

2. It is proposed to increase the quantity of air circulating in a mine, ventilated by a centrifugal fan, by erecting an additional similar fan in the neighbourhood of the existing fan. Is this practicable; and if so, how would you place the fans?

3. A fatal explosion was caused at a colliery last year by the tape fuse of a shot being fired in a break made by a previous shot; the fuse ignited the fire-damp, which the shot-firer stated could not be detected before he lit the fuse. Does any remark occur to you in connection with this accident?

*Practical Mining.*

1. Draw a plan showing how you would lay out the workings of a colliery for 120 men in each shift. Assume that one-half the output is required from bord-and-pillar workings, and one-half from long wall; and also that the depth is 100 fathoms, and give the size of pillars and pack walls. State the number of men in each district, indicate the course of the air by arrows, and give the quantity of air in each split; also show the position of all stoppings, crossings, doors, regulators, main ways, and landings.

*Surveying.*

1. Plot the following survey, and state the direction and length of the first line required to tie the first and last sets:—

| | Links |
|---|---|
| 1.—N. 86 W. ..... | 475 |
| 2.—N. 44 W. ..... | 160 |
| 3.—N. 11 E. ..... | 322 |
| 4.—N. 83 E. ..... | 290 |
| 5.—S. 7 E. ..... | 515 |
| 6.—S. 3 W. ..... | 170 |
| 7.—S. 86 E. ..... | 165 |
| 8.—Bearing and distance? | |

2. It is proposed to carry a colliery line across a valley 610 feet in width, as shown in the sketch, by means of an embankment 15 feet wide at the top and sloping 1 in 1. What is the content of the embankment in cubic yards? (Sketch omitted).

3. Describe a level, levelling staff, and chain. State what each is used for.

*Engineering.*

1. How would you fix the wire rope guides in a drawing shaft ?
2. Discuss the respective merits of underground and surface engines for pumping the water of a mine from the sump to the surface.
3. Design a winding engine to draw 1,000 tons per day of ten hours, and change the men ; the depth of the shaft being 100 fathoms, and the mean effective pressure of the steam 40 lb.

*Legislation.*

1. Define the term " ventilating district."
2. Quote General Rule 29 relating to the slipping of rope on drum.
3. What are the provisions of the Explosives Act with regard to the manufacture of blasting cartridges for private use ?

---

Newcastle (1st and 2nd Class), 1893.

*Arithmetic.*

1. Add nineteen million nine hundred thousand and nineteen ; one hundred and sixty million and six ; ten million one thousand one hundred and one ; three hundred and four million and forty thousand ; ten million three hundred thousand and three.
2. Add three thousand six hundred and seventy-four acres one rood and ten perches to four hundred and twenty-five acres two roods and nineteen perches.
3. Subtract 6,784,329 from 11,222,333 (giving your answer in words).
4. Subtract eleven miles sixteen chains seventeen yards from twenty-four miles thirteen yards.
5. Multiply six pounds four shillings and fivepence halfpenny by three thousand seven hundred and twenty-four.
6. Multiply ·065341 by ·00475.
7. Divide £617 8s. 7½d. by 234·5.
8. Divide the sum of $\frac{1}{4}$, $\frac{1}{3}$, and $\frac{3}{20}$ by the difference between $\frac{1}{5}$ and $\frac{1}{4}$.

*Machinery.*

1. Describe, with sketches, the best examples of the following machinery with which you are acquainted, and give principal dimensions—
   (*a*) Of a high-pressure winding engine ;
   (*b*) Of a condensing pumping engine ;

(*c*) Of a boiler for high-pressure steam (describing fittings and mountings necessary);

(*d*) Ventilating fan (and state its respective merits compared with other ventilating arrangements);

(*e*) Of a hauling engine.

*Pumping.*

1. Describe the action of lifting and forcing pumps, giving the terms used for all their parts.
2. A pumping engine goes seven strokes per minute, length of stroke 9 feet, diameter of p mp 17 inches; what is the quantity of water pumped per minute in gallons?

*Methods of Working and Ventilation.*

1. Sketch a district of bord and pillar workings for 20 hewers in a shift, and with the broken following up the whole workings.
2. Sketch a long wall district for 36 hewers in a shift. In each case indicate the course of the ventilation by arrows, and show the position of all stoppings, regulators, and doors.

*Timbering.*

1. Show, by plan and section, the method of timbering 5½-yard bord with a bad roof.
2. Show, by plan and section, the method of timbering and pillaring (the face of a gateway and two adjoining gateways for a distance of 10 yards back) in long wall working.

*Measurement of Air.*

1. Describe fully two methods of measuring an air current.
2. State the velocity at which you would have air travelling through the workings.
3. The current of air in a drift, 8 feet by 7 feet 2 inches, is such that powder-smoke passes along a distance of 60 yards in 14 seconds. What is the number of cubic feet of air passing per minute?

*Safety-Lamps.*

1. What description of safety-lamp are you familiar with?
2. Describe it, with a sketch, and state the points wherein you consider it superior or inferior to other safety-lamps.
3. How many apertures per square inch has the gauze?

*Explosives.*

1. Which explosive do you consider the safest for use in coal mines?
2. State your reasons, and explain what precautions you would take to prevent shots from blowing out.

*Coal Mines Regulation Act.*

1. State the regulations—
   (*a*) As to stations and inspections ;
   (*b*) As to circumstances under which notice to the inspector is required to be given ;
   (*c*) As to books and registers required (give a list) ;
   (*d*) As to hours of employment of boys, girls, and women ;
   (*e*) As to shot-firing.

---

NEWCASTLE (1ST CLASS), 1893.

*Sinking.*

1. Describe the method of sinking a shaft where quicksand is met with in the first 30 fathoms.
2. Give sketches and dimensions of the materials generally used while sinking through quicksand for a pit intended to be 12 feet diameter when finished.

*Surface Arrangements.*

1. Make a sketch showing the surface arrangements you consider necessary for a colliery having an output of 500 tons per day, and where there is pumping and ventilating machinery.

*Underground Arrangements.*

1. Draw a plan showing how you would lay out the workings of a colliery for 125 hewers in each shift.
2. Give the number of men in each district.
3. State the quantity of air in each split, and indicate its course by arrows.
4. Show the position of all stoppings, crossings, doors, and regulators.
5. Show main ways and landings.

   NOTE.—One half the output to be from bords and pillars, and one-half from long wall workings.

*Gases.*

1. What gases are met with in coal mines ?
2. Give an account of their nature and properties.
3. Supposing a level drift, 70 yards long, to be filled with fire-damp at the most explosive point, and that the air and gas could be separated, what length of the drift would each occupy ?
4. What amount of atmospheric air would render the above mixture non-explosive ?

*Ventilation.*

1. Explain the theory of the ventilation of mines, and say why artificial ventilation is more reliable than natural.
2. Explain the rule which should be followed in splitting the air, and state what is the practical limit to the number of splits, and why.
3. How should a deputy or other responsible official proceed to remove an accumulation of fire-damp in a working-place ?
4. Should such official report the condition of the place as he found it, or as he left it ?

*Furnace.*

1. Sketch a furnace suitable for 100,000 cubic feet of air per minute, giving its dimensions and relative positions to the shaft.

*Barometer and Thermometer.*

1. Explain the use of the barometer and thermometer.
2. How would you expect the gases in a mine to be affected by a fall or rise of the barometer ?
3. How does a change in the atmosphere, indicated by the thermometer, affect the condition of a mine ?

*Haulage.*

1. Describe, with sketches, any system of mechanical haulage with which you are familiar.
2. Describe the method of working it.
3. Explain fully the method of attaching and detaching tubs at the several landings and other places where necessary.
4. Describe the method of working curves and junctions.

*Dams.*

1. What precautions are necessary in selecting the position and preparing the place for a dam capable of resisting a pressure of from 50 to 100 fathoms of water ?
2. Sketch two such dams (giving the dimensions) one of timber, and one of brickwork, for a place 6 feet high and 8 feet wide.
3. What is the pressure, in lb. per square inch, due to a vertical column of water 75 fathoms in length ?

*Surveying and Levelling.*

1. Describe the ordinary method of surveying, and the instruments employed.
2. In using the magnetic needle, what precautions have you to take in surveying and plotting ?

3. Plot the following bearings, and state what should be the course and length of the seventh set to tie with the beginning of the first set :—

| No. | | Links. |
|---|---|---|
| 1 | S. 47¼ E. | 340 |
| 2 | S. 79½ W. | 160 |
| 3 | S. 30¾ E. | 424 |
| 4 | N. 62½ W. | 710 |
| 5 | N. 41 E. | 230 |
| 6 | N. 62½ W. | 340 |

4. Describe the system of levelling you are acquainted with, and show how to keep a level book, and reduce the levels.

---

WEST SCOTLAND DISTRICT (1ST CLASS), 1902.

*Mines Regulation Acts*, 1887 *to* 1896.

1. State the provisions of the Acts with regard to the inspection of the mine by the workmen, and say why in your opinion this is not more frequently done.
2. State the provisions of the Acts, with regard to check-weighmen.
3. State the General Rules as to the inspections of the workings.
4. State the provisions of the Acts as to plans.
5. What are the duties of a manager and of an under-manager under the Acts ?

*Ventilation.*

1. Plan No. 1 shows stoop and room workings in a 5 feet seam which gives off fire-damp. Show on the plan how they should be ventilated, noting where safety lamps should be used, and where naked lights. Give the quantity of air in each current, and show the brattices, screens, stoppings, regulators, and air-crossings. Show which roads should be used as drawing roads, and criticise the plan so far as ventilation is concerned. [Plan omitted.]
2. Plan No. 2 shows long wall workings in a 4 feet seam. Show on the plan how they should be ventilated, giving the quantity of air in each current, and showing the screens, stoppings, air-crossings, doors, and regulators. Criticise the plan so far as ventilation is concerned. [Plan omitted.

3. Make a sketch plan of a section of ten long wall places working to the rise (1 in 4) in a 5 feet seam, showing how the ventilation should be arranged to take the gas out of the face of the brushing where a considerable quantity is liable to accumulate.

4. The ventilation of a colliery is caused by a furnace which is placed at the bottom of a round shaft 10 feet in diameter and 150 fathoms deep. The downcast which is close to the upcast, is also 10 feet in diameter and 150 fathoms deep. The quantity of air is 60,000 cubic feet per minute, and the water-gauge at the separation doors at the pit bottom is 1 inch. What size of fan would it take to replace the furnace and increase the quantity of air to 80,000 cubic feet per minute? How many revolutions would it require to be driven? What water-gauge would be got and what size of engine would be required with a steam pressure of 100 lb. per square inch? (Co-efficient of friction, ·01 lb. per square foot of rubbing surface for a velocity of 1,000 feet per minute.)

5. What are the gases commonly found in mines? Describe their characteristics and give their chemical equivalents.

*Sinking, Fitting, and Pumping.*

1. Two shafts are to be sunk to a depth of 200 fathoms to win an area of 1,000 acres containing 24 feet of workable coal. It is proposed to draw 1,000 tons of coal per day, and it is not expected that the growth of water will exceed 1,000 gallons per minute. The surface consists of 120 feet of mud and wet sand. What size and shape of shafts would you propose to sink, and how would you proceed to sink through the mud?

2. Assuming that 500 gallons of water per minute were got in the shafts, in the previous question, in a post of cuttery sandstone 50 feet thick, just under the mud and sand, would you tub it back? If so, give particulars of the kind of tubbing you would use. If you would not tub back the water, state fully your reasons for so doing. The surface of the pit mouth is 200 fathoms above the position of the Lower Drumgray coal seam.

3. Compare the cost of striking a dry shaft 18 feet by 11 feet with that of a circular shaft 16 feet diameter, when miners' wages are 5s. 6d. per day. Discuss the advantages and disadvantages of each form.

4. Make a sketch plan of the pithead arrangements you would make for the colliery in question No. 1. There are three qualities of coal, and the dross is all to be washed together.
5. Describe fully how you would cope with an inrush of water of 200 gallons per minute coming from a fault at a point one mile from the pit bottom and 100 feet below the level of it.

*Winding and Haulage.*

1. What size of engine would you erect to draw 600 tons of coal per day of eight hours, from a shaft 200 fathoms deep? Steam pressure is 100 lb. per square inch, and hutch contains 10 cwt. of coal.
2. It is required to transmit by electricity 100 horse-power to be used for haulage purposes, a distance of one mile from the generator. What voltage would you use? What horse-power of engine and size and description of dynamo would you erect? What size of cables would you put in? and how would you carry them along the roadways underground?
3. Make a sketch of the best driving pulley for endless-rope haulage that you are acquainted with. State fully its advantages.
4. A dook dips 1 in 4, is fitted with endless rope haulage for a distance of 250 fathoms, from which level coal is being drawn, and is to be driven other 250 fathoms. What arrangement would you make for drawing the materials from the dooks while they are being driven, and for pumping the water, assuming the growth to be under thirty gallons per minute? The coal is $3\frac{1}{2}$ feet thick, and the dooks are to be driven long wall.
5. The water available for the boilers is very hard. What kind of boilers would you use, and what steps would you take to protect them? The hardness of the water is due to the presence of sulphate of lime in it.

*Surveying and Drawing.*

1. What instruments would you use in levelling a dook dipping 1 in 2, and what in a level road 1 in 100? What is the benefit of having levels on colliery plans? What datum would you use in putting the figures on the plan?
2. Plot the following bearings to a scale of 1 inch = a chain, and find, and mark on your paper, the length and bearing of a line drawn from the starting point to the end of the fourth bearing:—

| No. | Links. |
|---|---|
| 1.—N. 20 E. ..... | 292 |
| 2.—N. 80 E. ..... | 200 |
| 3.—S. 77 E. ..... | 320 |
| 4.—S. 25 E. ..... | 240 |
| 5.—S. 40 W. ..... | 270 |
| 6.—S. 67 W. ..... | 315 |
| 7.—N. 38½ W. ..... | 393 |

3. Give in detail, the deductions on measurements, made on inclined planes, so that they can be plotted to horizontal lengths as follows:—
   (*a*) 1 in 1..... 345 links.
   (*b*) 1 in 2..... 430 „
   (*c*) 1 in 4..... 520 „
4. Sketch and describe in two different sections, the details of an air-crossing, 6 feet wide and 4 feet high, in a seam of coal 4½ feet thick. State what materials you would use, and the reasons for your preference.
5. Sketch neatly, sections of the various seams of mineral you have worked, including 4 to 6 feet of the roof and pavement giving all details of stony ribs in the seam—whether worked by stoop and room or long wall, and how much a collier puts out per day. State the name of the colliery.

*Modes of Working.*

1. What are the features of a seam of coal you would prefer to work by stoop and room rather than by long wall? State the nature of the coal, roof, and pavement that in your opinion is most suitable for that method of working. Give your reasons for preferring long wall to stoop and room. Do you know of any seam that would work better by some other system than by either of the above methods?
2. A seam of coal 4 feet thick, at a depth of 150 fathoms, with good roof and pavements, has to be worked by stoop and room, dip 1 in 10. Show by sketches and figures how you would lay off the pit bottom pillars, and their sizes, around the two shafts, both of which have to wind coal. Show on sketch the sizes of ten ordinary pillars level course on each side of the pit bottom, four to the rise and six to the dip. Would you make the pillars the same size if the depth was 80 fathoms? Give your reasons for any change you suggest. Show the method of ventilation, with air-crossings, trap doors,

and stoppings, and how you would keep the water from rise workings from getting to the dip.

3. A seam of coal 6½ feet thick, dip 1 in 6, is to be worked by long wall. What width of roads and wall faces from centre to centre, and how much brushing of hard blaes roof would be required to be taken in the first instance to build and pack the sides of the roads at (*a*) 100 fathoms deep, (*b*) 200 fathoms deep? Show by sketches in plans and sections the above queries, marking sizes in figures at each depth from surface.

4. Make a sketch of a section of stooping of pillars 50 yards square in a 6 feet seam, with a good roof, showing the outline of the pillars taken out, so that none of the pillars will be left too far behind and have to bear too much weight on them. Make a sketch to an enlarged scale of a single pillar, showing all the lifts, and the order in which each is taken out, and also the position of the rails in each lift. How many props would be set in each lift?

5. What is your experience generally of coal-cutting machines? What seams as to thickness of coal, roof, and pavement, in your opinion, are they to be preferred to manual labour? Show on sketch plan how you would prepare an ordinary section of ten long wall faces to be worked by a coal-cutting machine. What is your experience as to the benefits to be derived from working by machines? Compare them as to cost of production, and as to roundness of coal with hand labour.

*Arithmetic.*

1. What is the cube root of 12, 95,213,625?

2. The miner's nominal wage is 37½ per cent. over the basis rate, which is 4s. per day. What should the rate per ton be when the darg is 3 tons?

3. What is the cost per fathom of lining a circular pit 16 feet in diameter with brickwork 9 inches thick at the rate of 17s. per cubic yard?

4. What is the total output per annum at a colliery where the boiler consumption is 8,000 tons per annum, and is 6 per cent. of the total output?

5. An air-way is arched with a semi-circular arch. The clear roadway is 10 feet wide and 6½ feet high. Find the area in square feet.

*Explosives and Strength of Material.*

1. State your objection to using compressed gunpowder cartridges which are not about the same diameter as the shot-hole.
2. What is the principal danger to be guarded against in the use of the nitro-glycerine compounds? What arrangements would you make to guard against this danger?
3. What thickness should a cast iron pipe 6 inches diameter be made to have a bursting pressure of 4,000 lb. per square inch?
4. What size of sling chain would you use to lift 20 tons of pipes?

---

WEST SCOTLAND (2ND CLASS), 1902.

*Mines Regulation Acts, 1887 to 1896.*

1. State the provisions of the Acts with regard to the inspection of the mine by the workmen, and say why, in your opinion, this is not more frequently done.
2. State the provisions of the Act with regard to checkweighmen.
3. State the General Rules as to the inspections of the workings.
4. State the provisions of the Acts as to plans.
5. What are the duties of a manager and of an under-manager under the Acts?

*Ventilation.*

1. Plan No. 2 shows long wall workings in a 5 feet seam which gives off a considerable quantity of fire-damp. Show on the plan how you would ventilate them, giving the quantity of air in each current, and showing the screens, stoppings, air-crossings, doors, and regulators. Criticise the plan so far as ventilation is concerned. [Plan omitted.]
2. Make a sketch plan of a section of ten long wall places working to the rise (1 in 4) in a 5 feet seam, showing how the ventilation should be arranged to take the gas out of the face of the brushing, where a considerable quantity is liable to accumulate.
3. State what practical experience you have had in the ventilation of collieries.

*Sinking, Fitting, and Pumping.*

1. Sketch a sinking kettle to hold about 15 cwt., giving principal dimensions.

2. Give sketch with dimensions of a hydraulic joint on a 6-inch pipe for a working pressure of 1,000 lb. per square inch.
3. What size of pump would you put in to raise 250 gallons per minute, allowing the engine to stand six hours out of the twenty-four.
4. In pumping water from a depth of 400 fathoms from the surface, what vertical head would you allow for each lift of pumps? What kind of valve would you use?
5. How many vertical feet would you expect a 3-inch siphon to lift water if distance from summit to suction is 200 fathoms, and delivery end is vertical and is 15 fathoms long?

*Winding and Haulage.*

1. Sketch and describe the best haulage clip you are acquainted with for drawing up hill 1 in 8.
2. What is the flattest inclination on which an incline will self-act if rakes consist of twelve hutches, the gross weight of each hutch being 14 cwt. and the tare 4 cwt? The incline is 300 fathoms long, and the rope weighs 3 lb. per fathom.
3. Sketch with dimensions a cage suitable for raising two hutches each containing 10 cwt. of coal.
4. What is the average distance per day travelled by (*a*) a drawer collecting single hutches from the faces to a lye an average distance of 75 fathoms per rake? (*b*) A pony collecting hutches in rakes of two or three from the faces to a lye an average distance of 100 fathoms per rake? (*c*) A pony going along a level road from a lye to the haulage terminus or pit-bottom an average distance of 250 fathoms per rake?
5. Describe in detail with sketches how you would apply the cut-chain system of haulage to the drawing of a heading rising 1 in 4 with branches to both sides.

*Surveying and Drawing.*

1. Show face of a common dial with the position of the sights and needle, when you are about to lay out a mine to go N. 45 degrees W., and another one to go N. 80 degrees E.
2. Sketch neatly a hutch road, and branch off it at right angles. The rails are 6 feet long, malleable iron, bridge pattern. Show the position of the points, crossings, sleepers, and spikes. The length to be sketched of the main road to be about 18 feet and the branch 12 feet. The ra are 15 lb. to the yard, and the gauge 26 inches.

3. Sketch a section of the various seams of coal you have worked. Show the strata for 5 feet above and below the coal, and also the seam with any ribs of stone or blaes in it.
4. The following survey of workings is to be plotted to a scale of 1 inch to a chain. The beginning and end of these bearings, A and B, to be connected by a mine. Give the direction of the mine and its length.

*Modes of Working Coal and other Minerals.*

1. Give a short description of the various modes of working coal, as practised in this country, explaining fully the circumstances under which each system is most suitable.
2. Sketch and describe how you would renew old broken timber in a horse road 250 yards long, 6 feet wide, by 5½ feet high, so as not to interfere with the traffic, which goes eight hours in the twenty-four. It is a return air-course, with bad air passing through it, and having considerable weight on the timber, the depth being 80 fathoms. State what sizes you would prefer, and what measures you would take to preserve the new timber in future.
3. Sketch how you would work a seam of coal 5 feet thick at an angle of 30 degrees and at 85 fathoms deep by stoop and room. Show in section how you would take out the pillars. If you prefer to work by long wall, show how the coal would be taken to the main roads.
4. In a seam of coal 5 feet thick, with an average roof and pavement, what size of stoops and rooms would you adopt to get the largest amount of coal possible, consistent with safety and economy, and what would be the percentage of coal left in the pillars, (*a*) at 80 fathoms in depth; (*b*) at 150 fathoms in depth; (*c*) at 200 fathoms in depth?

*Arithmetic.*

1. What is the square root of 5,490,592?
2. A long wall place is 50 feet long, and the coal is 24 inches thick. If brushing costs 14s. per fathom, how much does it cost per ton? (30 cubic feet of coal weigh 1 ton.)
3. A roadway is timbered with sets of timber every 2½ feet. Each set consists of two legs and a crown. The legs are 6 feet and the crown is 10 feet long. If timber costs 28s. per 100 feet, what is the cost of timber per fathom of the roadway?

*Explosives and Strength of Materials.*

1. What explosive would you use in (*a*) coal, (*b*) hard fakes brushing, (*c*) a whin mine ?
2. What is the breaking strain of a beam 8 feet long, 18 inches deep, and 12 inches broad, loaded in the middle and supported at both ends, if a beam 12 inches long and 1 inch square, supported and loaded in the same way, breaks with 500 lb. ?

---

Stafford District (1st Class), 1902.

*Ventilation.*

1. What advantage is gained by splitting air in mines, what rules should be observed, and what methods adopted ? Give sketches.
2. How does the power to overcome friction of air in mines vary with the perimeter, length of rubbing surface, area and velocity ?
3. Discuss the barometer, thermometer, and anemometer, and state their use in connection with collieries.
4. What are the General Rules in the Act which refer to the ventilation of mines, and how do they affect the case of a fan requiring stopping for repairs ?
5. Sketch and give a description of either a Guibal or Waddle fan or any other fan you may be acquainted with.
6. If a fan running sixty-five revolutions per minute gives 100,000 cubic feet of air per minute, the water-gauge being 2·5, give the horse power of the air by increasing the volume to 150,000 cubic feet per minute, give the water-gauge, horse-power, and number of revolutions of the fan.
7. What will be the effective horse-power of a ventilating fan when a volume of 250,000 cubic feet of air per minute is circulated, and the ventilating pressure equals 19 lb. per square foot ?
8. Ventilate the accompanying plan. [Plan omitted.]

*Gases and Lighting.*

9. What are the gases met with in mines ? Give their symbol and specific gravity, methods of detecting them, and proportion of atmospheric air which renders them harmless.
10. What gases are given off from spontaneous combustion ? Describe their properties.
11. Give the General Rule referring to safety-lamps.

12. Which do you consider the best and most efficient safety-lamp for use in :
    (*a*) A seam lying at an angle of 50 degrees ?
    (*b*) In one lying flat ?
    (*c*) Give the lighting power of each.

*Spontaneous Combustion.*

13. Explain fully how you would proceed to re-open a mine after an explosion due to gob-fire—the seat of the fire being unknown, the seam being a gaseous one, and lying at an angle of 30 degrees—and state what gases you would meet with.
14. How would you lay out and work a gaseous seam of coal lying at an angle of 45 degrees liable to spontaneous combustion ? Give sketch.

*Geology.*

15. Discuss the use of geology to the mining engineer.
16. What can be learnt from the fossils met with in the coal measures ?
17. Give a section of the coal-field you are acquainted with. State some of its principal geological features.

*Ambulance.*

18. Do you hold an ambulance certificate ?
19. If at any time you have rendered first aid, give a short account of the same.
20. Give your idea of a central rescue station. Do you consider these stations advisable, and to what radius should they be limited ? Also state what appliances, &c., you consider necessary to be kept at the station.

*Engineering.*

1. Describe the safest and most economical boiler for generating steam with which you are acquainted.
2. What fittings should each boiler have ? State what precautions should be taken to avoid accidents.
3. Describe or sketch the method of seating a Lancashire boiler, and also the method of connecting the steam and feed waterpipes where there are several boilers in a battery.
4. Name some of the chief impurities in boiler feed water. What difficulties or dangers arise from using impure water, and what precautions would you adopt where you were compelled to use it ?

5. What method would you employ for supplying high pressure boilers with feed-water? Describe or sketch the most efficient arrangement for heating feed-water with which you are acquainted.
6. What size and type of winding engines would you employ for raising 800 tons in eight hours from a shaft 500 yards deep? State what steam pressure you would use, and give the principal dimensions of the engines.
7. What are the respective advantages and disadvantages of slide valves, piston valves, and Cornish or double-beat valves for winding engines?
8. Sketch a slide valve, piston valve, Cornish or double-beat valve.
9. What, in your opinion, is the best type of piston? Give sketches of two different types.
10. Describe briefly the use of a steam engine indicator, and show by sketch how you would connect one to an engine to take a diagram.
11. If a new pair of winding engines was using too much steam, describe in what way the indicator would help you to ascertain the cause, and state how you would proceed to remedy the defect.
12. Sketch a pump suitable for raising 6,000 gallons of water per hour through a vertical height of 160 yards, and give principal dimensions.
13. What size engines would you employ for driving two endless rope haulages, the load upon each rope being 14 tons dead weight? Show by sketch how you would arrange the engines and gear for driving the two ropes, indicating where you would fix clutches.
14. Explain what is meant by using steam expansively, and explain how you can economise steam consumption by condensing.
15. Describe with sketches how you would fix conductors (either wooden rods or wire guides) in a shaft 16 feet diameter.
16. How would you attach a new winding rope to a cage, and what method would you adopt for regulating the length of the rope?

*Electricity.*

1. Define the terms kilowatt, ampere, volt, B.T.U.
2. Sketch the circuits of (a) a series-wound dynamo, (b) a shunt-wound dynamo.

3. Describe the best switch with which you are acquainted for controlling a 10 B.H.P. motor.
4. What system and construction of cables would you consider best for carrying a continuous current of 500 volts down a shaft 500 yards deep and along the working roads? How would you fix the cables, and what steps would you take to preserve them from mechanical injury, and to avoid risk of injury to workmen?

*Sinking.*

1. Describe or show by sketch how you would lay out the surface arrangements of an ordinary sinking shaft.
2. Describe a method of fixing and sketch—
   (*a*) An ordinary walling crib,
   (*b*) A water or garland crib.
3. In sinking two shafts a feeder of water yielding 100 gallons per minute is met with at a depth of 250 yards. State how you would deal with it so as to proceed with the sinking without delay.
4. Give a sketch of a bricking scaffold, and state how you would raise and lower same, and how you would support it whilst bricking, and what you would do with it whilst sinking.

*Surveying.*

1. Give a short description of the usual mode of making a surface survey, and show how you would survey the estate shown on plan No. 1 attached. [Plan omitted.]
2. Describe the method of making an underground survey with (1) the loose needle, (2) the vernier, and show how you would keep your field book in each case.
3. What modes of plotting the above are you acquainted with?
4. How would you level underground with steep inclinations, and with a very moderate inclination?
5. What are the requirements of the Coal Mines Regulation Acts with regard to vertical and horizontal sections, and faults or dislocations of the seam?

*Laying out a Colliery under Various Conditions.*

[Candidates unacquainted with the South Staffordshire Thick Coal Seam are not required to answer questions relating thereto.]

1. If you had an estate of 120 acres of South Staffordshire Thick Coal of the section stated below, and with a strong bearer, upon what system should you work it? State why.

| *Bearer or Rock.* | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Rooves coal ..... | 1 | 0 | — | |
| Top slipper coal ..... | 3 | 0 | — | |
| Jays „ ..... | 2 | 0 | — | |
| Lambs „ ..... | 2 | 0 | — | |
| Tow „ ..... | 5 | 0 | — | |
| Bat „ ..... | — | | 0 | 4 |
| Brazils „ ..... | 3 | 6 | — | |
| Hard stone ..... | — | | 1 | 6 |
| Stone coal ..... | 2 | 9 | — | |
| Dundicks coal ..... | 0 | 6 | — | |
| Patchells „ ..... | 1 | 6 | — | |
| Swayer „ ..... | 4 | 6 | — | |
| Dice „ ..... | 0 | 6 | — | |
| Benches „ ..... | 2 | 0 | — | |
| | 28 | 3 | 1 | 10 |

2. Upon what system would you work an estate of 150 acres where the South Staffordshire Thick coal was of the following section, the coal tender and the bearer not strong ?

| *Black Bat.* | Ft. | in. | Ft. | in. |
|---|---|---|---|---|
| Rooves coal ..... | 1 | 8 | — | |
| Spires „ ..... | 3 | 0 | — | |
| White „ ..... | 3 | 0 | — | |
| Fleurs „ ..... | 1 | 6 | — | |
| Tow „ ..... | 3 | 2 | — | |
| Brazils „ ..... | 1 | 6 | — | |
| Bat „ ..... | — | | 0 | 5 |
| Fine „ ..... | 2 | 7 | — | |
| Veins „ ..... | 2 | 0 | — | |
| Bat ..... | — | | 0 | 6 |
| Stone „ ..... | 2 | 0 | — | |
| Patchells „ ..... | 2 | 6 | — | |
| Swayer „ ..... | 1 | 7 | — | |
| Slipper „ ..... | 3 | 0 | — | |
| Dice „ ..... | 0 | 9 | — | |
| Benches „ ..... | 1 | 8 | — | |
| | 29 | 11 | 0 | 11 |

NOTE.—The Veins coal is strong, but of no commercial value.

3. Assume the depth to the coal in the last two questions to be 250 yards, and to have an inclination of 1 in 20 ; show

on plan No. 2 the position of the shafts, roads, workings, and mode of ventilation you would arrange for one of the seams in the last two questions. [Plan omitted.]

4. State your experience in working South Staffordshire Thick coal ribs and pillars, and state the chief difficulties met with.

5. Name and describe with sketches the different methods of working coal with which you are acquainted, and explain what circumstances with reference to the nature of the floor and roof and nature and thickness of the coal are most suitable for each method.

6. With seams of coal as below how should you proceed to work them? State your reasons.

*First Seam.*

| | Ft. in. | Ft. in. |
|---|---|---|
| Rock | | |
| Coal ..... | 0 10 | — |
| Bat ..... | — | 0 3 |
| Coal ..... | 0 10 | — |
| Bat ..... | — | 0 6 |
| Coal ..... | 0 2 | — |
| Bat ..... | — | 0 9 |
| Coal ..... | 0 6 | — |
| Bat ..... | — | 0 3 |
| Coal ..... | 3 9 | — |

*Second Seam.*

| | Ft. in. | Ft. in. |
|---|---|---|
| Soft binds. | | |
| Coal ..... | 2 6 | — |
| Dirt ..... | — | 0 2 |
| Coal ..... | 4 6 | — |
| Dirt ..... | — | 0 5 |
| Strong fireclay ..... | — | 0 9 |
| Strong rock. | | |

7. Plan No. 3 is intended to represent an estate of 600 acres under which the seams in the last question lie at a depth of 300 yards and 350 yards. Show on the plan the position of the shafts, roads, workings, and mode of ventilation and state the diameter of the shaft you recommend for an output of 500 tons a day for one of the seams, and state which of the seams your plan refers to. [Plan omitted.]

*Underground Management, Practical Ventilation, Timbering, Shot-firing, and General Knowledge of Explosives.*

1. Name a few important points which in your opinion are necessary for underground management.
2. In South Staffordshire Thick coal workings how would you arrange to ventilate the openings ?
3. Give sketches of the best arrangements for air-crossings either over or under, which you know, and say generally what your views are with reference to them.
4. In long wall where there is gas, how should you arrange to ventilate the wastes, and what should you do with abandoned roads ?
5. State the requirements of the Mines Regulation Acts as to (1) stations ; (2) inspections before commencing work ; (3) inspections during shifts ; (4) as to securing roofs and sides and provision of timber ; (5) ventilation and measurement of the same.
6. Give your experience of timbering in roads and faces. Explain the difficulties against which the timbering had to contend, and show by sketches the way in which the timber was fixed to meet such difficulties.
7. Where do you consider cogging most useful in South Staffordshire Thick Coal workings ?
8. How would you proceed to raise the height of a road where the roof is already heavy on existing timber ?
9. What are the instructions given in the Home Office Order, October, 1901, with regard to detonators ?
10. Under what conditions are the explosives *not* on the Permitted List not allowed to be used in a mine ?
11. Under what conditions can the explosives on the Permitted List be used ?
12. In blasting describe : (1) Making the bore-hole ; (2) cleansing the bore-hole ; (3) tamping the bore-hole ; (4) ramming the bore-hole.
13. What are the advantages of packing the goaves in long wall work ?
14. What conditions are conducive to spontaneous fires, and what are their first indications ?
15. Describe shortly the constituents of the high explosives with which you are acquainted, and give the comparative power of high explosives as compared with compressed gunpowder. Name their advantages and disadvantages as compared with gunpowder.

## STAFFORD DISTRICT (2ND CLASS), 1902.

### *Arithmetic.*

1. The area of a block of coal is 5,760 yards ; what is the area in acres, roods, perches, and yards ? (Statute measure.) What weight of coal is there in the block, the seam being 3 feet 3 inches thick, and weighing 18 cwt. to the cubic yard ?
2. If a collier and his drawer get 4 tons of coal for which he is paid 3s. 6½d. per ton, and he pays his drawer 30 per cent. of what he receives, how much will he have left for himself ?
3. If two pits are winding respectively, No. 1 pit, 1,273 tons 10 cwt. per day, and No. 2 pit, 729 tons 10 cwt. per day, the cost per ton at No. 1 pit being 4s. 1½d., and at No. 2 pit 6s. 1d. per ton, what will be the average cost per ton, taking the two pits together ?

### *Coal Mines Acts, Special Rules, and the Explosives Order.*

1. State the provisions for persons working machinery underground and on the surface. State the time children may be employed above and below ground per day, and per week, under the Coal Mines Regulation Acts.
2. What are the duties of an under-manager as described by the General and Special Rules ?
3. What are the conditions now laid down with regard to shot-firing in mines, having in view the conditions as published in the Explosives in Coal Mines Order of October 1st, 1901 ?
4. What are the General and Special Rules to be observed by sinkers ?
5. In mines where safety-lamps are in use, what are the precautions to be observed by the workmen in regard to their use ?

### *Practical Working.*

1. What system of coal working have you been accustomed to ? Describe same with sketches, and also the system of timbering.
2. Describe the working of compound hauling engines, and explain their advantages and disadvantages over other engines.
3. If you are working packs in a seam of coal 6 feet thick, with a strong roof, what is most essential that the officials should pay particular attention to ? Give the reasons for your answer.
4. State the conditions which may tend to bring about a boiler explosion.

5. When withdrawing timber, what precautions would you take—(*a*) when loosening the timber; (*b*) when removing it from the fall? What tools do you consider necessary for this work?

*Mine Gases, Lighting, and Ventilation.*

1. What, in your opinion, is the best safety-lamp? Describe it, with three others you are acquainted with. Give the reasons for your opinion.
2. If the ventilating fan was damaged or the furnace put out by an explosion, and you found the returns full of fire-damp, what temporary means would you adopt to restore the ventilation?
3. In a mine giving off a large quantity of fire-damp how would you ascertain if the mine was properly ventilated?
4. If 10,000 cubic feet of air are circulating through a mine, and you want to increase it to 20,000 cubic feet, how much must the ventilating current be increased?
5. Show how you would ventilate the workings on the annexed plan, having due regard to requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Act. (Plan not reproduced.)

---

STAFFORD DISTRICT (1ST CLASS), 1901.

*Ventilation.*

1. State the rules that are applicable to the resistance of air travelling through a mine: describe and state how you would be guided by such rules in laying out the general ventilation of a mine.
2. The total quantity of air circulating in a mine ventilated by a fan and natural ventilation combined is 100,000 cubic feet per minute. The quantity circulating when the fan is standing is 25,000 cubic feet per minute; what quantity would circulate if the effect of natural ventilation could be eliminated?
3. If 40,000 cubic feet of air per minute are passing through one split in a mine, which is gauged by a regulator having an opening 3 feet by 6 feet, what quantity will pass if the opening be increased to 4 feet by 6 feet?
4. Ventilate accompanying plan, marking by arrows the direction of the air-currents, putting in the necessary stoppings, doors, brattices, and lamp stations, having due regard to getting the coal from the coal faces. [Plan omitted.]

*Chemistry.*

1. What is meant by the diffusion of gases, and how is it utilised in ventilation ?
2. What are the chemical causes of spontaneous combustion in a coal mine, and what are the resultant gases ?
3. Describe how electricity is produced :—(1) By primary battery ; (2) by dynamo.

*Geology.*

1. Describe the chief characteristics of the carboniferous strata and of the strata overlying and underlying them in ordinary sequence.
2. Describe the faults usually found in coal measures, and give your opinion how they are formed.

*Arithmetic.*

1. How many tons of water will a double-acting ram pump, 10 inches diameter, 20 inches stroke, 20 strokes per minute, discharge in a day of eight hours ?
2. What quantity of fuel will be required per day, eight hours, to generate steam for an engine 20 inches cylinder, 40 inches stroke, running 60 revolutions per minute, average steam pressure 50 lb., allowing a consumption of $2\frac{1}{2}$ lb. per horse-power per hour ?
3. (1) Give the square root of 18,900 ; (2) Give the cube root of 29,791,000.

*Mining Operations Generally.*

1. The following is the section of the strata, where it is proposed to sink a shaft :—

| | Feet. |
|---|---|
| Soil | 2 |
| Clay | 4 |
| Wet running sand | 6 |
| Clay | 15 |
| Sandstone Rock | — |

Explain with sketches how you would sink through this, the finished size of the pit to be 14 feet diameter.

2. Describe the ordinary operations in sinking a 14 feet shaft ; what precautions you would take for the safety of the men employed in sinking the above ?
3. Describe how you would put in the following curbs :—
   (1) Ordinary bricking curb ;
   (2) Garland curb ;
   (3) Wedging curb for tubbing.

4. Give a description, with sketches, of the method of working the seam of coal you are best acquainted with, and the different methods of timbering you would adopt.
5. Describe how a steam engine is indicated, and what are the advantages of doing so.
6. Describe the method of bringing coal from the working face to the main level in a seam at an angle of 1 in 3. What appliance would you adopt, and what precautions would you take to prevent accidents ?
7. Give sketch as to how you would attach a wire rope to a cage, and state the principal points to be attended to to ensure the safe working of the rope.
8. How would you commence a survey from the pit bottom where steel girders and rails are used, and what precautions would you take to ensure accuracy ?

---

Stafford District (2nd Class), 1901.

*Ventilation.*

1. How is ventilation produced in mines ? Describe one method.
2. One hundred and twenty thousand cubic feet of air are passing along an air-course ; the water-gauge is 2·25 ; what is the horse-power ?
3. You have to build a stopping to cut off a gob-fire 25 yards beyond the last thirling ; describe how you would carry the air to the workmen.
4. In an air-way 5 by 6 feet, the velocity of the air is 360 feet per minute ; what is the quantity of air in cubic feet that is passing ?
5. Ventilate accompanying plan, marking by arrows the direction of the air-currents, putting in the necessary stoppings, doors, brattices, and lamp stations, having due regard to getting the coal from the coal faces. [Plan omitted.]

*Chemistry.*

1. Give a list of the various gases met with in mining, their symbols, and the effect caused by each of them.
2. How are gob fires caused in coal mines ?
3. How many pounds avoirdupois will 130 cubic feet of air weigh in normal temperature and pressure ?

*Arithmetic.*

1. How many gallons will a cylinder 30 feet by 8 feet hold ?

2. Work out the horse-power of an engine, 16-inch cylinder, 3 feet stroke, running sixty strokes per minute, average steam pressure 60 lb. per square inch.
3. A stallman employs two men, one at 6s. 4d., the other at 7s. 6d. per day, for six days; he sent 65 tons at 2s. 3d. per ton; what remains for him after paying his men?

*Mining Operations.*

1. Describe the method of bringing coal from the face to the main level in a seam at an angle of 1 in 3; what appliances would you use, and what precautions would you adopt to prevent accidents?
2. What precautions are necessary in approaching old workings supposed to contain water or gas?
3. Describe, with sketches, how you would timber levels and drifts in a 5 feet seam with a heavy roof.
4. What are the duties of an under-manager as described in the Coal Mines Regulation Act, 1887?
5. Describe, with sketches, how you would fix the following curbs in sinking a shaft 14 feet diameter:—(*a*) Ordinary bricking curb; (*b*) garland curb; (*c*) wedging curb for tubbing.
6. Describe, with sketches, what system of underground haulage you are acquainted with.
7. What is the extreme vertical height that a pump will draw water? Explain reason why.

## GLAMORGAN EDUCATION COMMITTEE EXAMINATION QUESTIONS.

### First Year: Elementary Course.

*Section A.*

1. Define the following terms:—"Dip," "Strike," "Fault," "Stratum."
2. What precautions would you adopt in approaching old workings?
3. Describe the tools you would use, and the operations of drilling and charging shot-holes and the firing of shots.
4. Explain the construction of any safety-lamp with which you are familiar.
5. What are the advantages of splitting the air-current in mines?
6. How do you secure wire-rope guides to the headgear, and what arrangements are made to keep the guides rigid?
7. Describe the construction and use of the water-gauge in mining.
8. Describe in detail, giving dimensions, &c., the tools used by a timberman in your district.

*Section B.*

9. Convert into vulgar fractions 1·002. Express in decimals $\frac{25}{750}$.
10. Find in inches the length of each side of a square whose area is ·144 square feet.
11. What will it cost per lineal yard to drive a hard heading 11 feet wide by 8 feet high at 5s. per cubic yard?
12. What weight of water will a tank 10 feet by 4 feet by 3 feet contain?
13. What is the perimeter of an air-way 6 feet high by 8 feet wide?

### Second Year.—Elementary Course.

*Section A.*

1. How would you ventilate the space below the scaffold when bricking in a sinking shaft?
2. Explain with sketches the different forms in which timber is used in the mine for supporting roof or sides: first, of working faces; second, of haulage roads.

3. Describe the long wall system of working coal. What are its advantages and disadvantages ?
4. Describe any modern fan, with sketches.
5. What is the effect on the action of a pump—(*a*) If a joint leaks in the delivery pipes; (*b*) if a joint leaks in the suction pipes ?
6. How is the rail fastened to a steel sleeper ? Compare steel and wooden sleepers.
7. In laying out new colliery plant would you put up your gearing for round or flat ropes ? And why ?

*Section B.*

8. If you pay 1¼d. per inch thick per yard forward for ripping top 6 feet wide, how much does the ripping cost per cubic yard ?
9. What will be the difference in pressure per square foot when the barometer falls from 30 inches to 29·5 ?
10. If the temperature in the downcast is 45° Fah., with 100,000 cubic feet of air per minute passing, what volume passes up the upcast per minute if the temperature is 81° Fah. ?
11. How is the horse-power of an engine calculated ?
12. If with a water-gauge of 2·25 you have 120,000 cubic feet of air per minute, what quantity would you get for 4 inches ? What would the H.P. be in each case ?

THIRD YEAR'S COURSE.—ADVANCED.

*Section A.*

1. What is coal ? Describe the different varieties, and as far as possible name the localities in your own county where each variety may be obtained.
2. Describe in detail a method of working a seam 3 feet thick with good roof at an inclination of 2 feet per yard.
3. What is a detonator ? Explain the difference between high tension and low tension detonators.
4. Describe endless rope haulage in two modifications.
5. What are the circumstances which govern the form and size of the coal pillar left around a shaft ?
6. If you had to put in electric signals for a haulage plane 600 yards long, write out a complete list of all the materials you would require.
7. How can steel or iron be used instead of timber underground for supporting roof and sides ?

*Section B.*

8. Define the terms unit of work, horse-power, centre of gravity, co-efficient of friction.
9. Three forces act at a point and keep it at rest. Show how to draw a triangle whose sides shall represent the forces.
10. The diameter of a drum for a flat rope is 5 feet. The rope is $\frac{5}{8}$ inch thick, number of revolutions 34¼. What is the depth of the pit ?
11. A simple screw jack is employed to raise a weight of 5 tons. The screw has a pitch of half an inch, and the lever is 30 inches long. What power has to be applied at end of lever ?
12. What pressure must a horse exert in keeping back a tram weighing 30 cwt. in going down a heading having a gradient of 3 inches per yard ; friction, one thirtieth ?

Fourth Year's Course.—Advanced.

*Section A.*

1. Describe with sketches the Waddle fan.
2. Sketch and explain the construction of any two modern safety-lamps, stating under what conditions you would consider them safe.
3. Describe the pulsometer.
4. What methods have been adopted for equalising the load on winding engines ?
5. Describe the process of boring by the Diamond drill.
6. If a 10 feet upcast shaft has to be enlarged to 15 feet diameter, how would you proceed to carry out the work, supposing the ventilating current had to be maintained during operations ?
7. What are the different forms of screens used for sizing coal ?
8. Describe with sketches the necessary fittings for a Lancashire boiler.

*Section B.*

9. Convert 25° F. into Centigrade. 2 C. into Fahrenheit.
10. Explain the principle of the Vernier.
11. What size pumping engine would you erect to raise 300 gallons per minute up a shaft 150 yards deep ?

12. How much must the pressure or head of water be increased to pass the same quantity of water through 16 four-inch pipes as through one 16-inch pipe ?

13. The breaking strain applied at the centre of a beam 10 inches deep and 6 inches wide is 8 tons. What would be the breaking strain if the same beam was laid so that the depth would be 6 inches and width 10 inches ?

5. When withdrawing timber, what precautions would you take—(*a*) when loosening the timber; (*b*) when removing it from the fall? What tools do you consider necessary for this work?

*Mine Gases, Lighting, and Ventilation.*

1. What, in your opinion, is the best safety-lamp? Describe it, with three others you are acquainted with. Give the reasons for your opinion.
2. If the ventilating fan was damaged or the furnace put out by an explosion, and you found the returns full of fire-damp, what temporary means would you adopt to restore the ventilation?
3. In a mine giving off a large quantity of fire-damp how would you ascertain if the mine was properly ventilated?
4. If 10,000 cubic feet of air are circulating through a mine, and you want to increase it to 20,000 cubic feet, how much must the ventilating current be increased?
5. Show how you would ventilate the workings on the annexed plan, having due regard to requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Act. (Plan not reproduced.)

---

STAFFORD DISTRICT (1ST CLASS), 1901.

*Ventilation.*

1. State the rules that are applicable to the resistance of air travelling through a mine: describe and state how you would be guided by such rules in laying out the general ventilation of a mine.
2. The total quantity of air circulating in a mine ventilated by a fan and natural ventilation combined is 100,000 cubic feet per minute. The quantity circulating when the fan is standing is 25,000 cubic feet per minute; what quantity would circulate if the effect of natural ventilation could be eliminated?
3. If 40,000 cubic feet of air per minute are passing through one split in a mine, which is gauged by a regulator having an opening 3 feet by 6 feet, what quantity will pass if the opening be increased to 4 feet by 6 feet?
4. Ventilate accompanying plan, marking by arrows the direction of the air-currents, putting in the necessary stoppings, doors, brattices, and lamp stations, having due regard to getting the coal from the coal faces. [Plan omitted.]

10. In sinking a deep shaft to a new seam, what are all the precautions you think necessary ?

*Arithmetic.*

1. Two men earn £15 2s. 6d. in 11 days, out of which they pay 18s. 9d. off-takes :
   (*a*) What is the net daily wage ?
   (*b*) What would it be after an increase of 8¼ per cent. ?
2. Divide 3 tons 2 cwt. 3 qrs. 22 lb. by 56 ; and find the value of each part at 1s. per cwt.
3. What quantity of water, in gallons, and what weight, in tons, are contained in a tank 10 feet by 10 feet by 10 feet ?
4. Two miners hew 80 tons of coal at 2s. 5½d., and cut 4 yards at 5s. 3d. per yard ; one works eleven shifts, and receives 2s. in the £ more than his mate, who works ten shifts. What are the respective earnings ?

*Winning and Working of Coal and Shale.*

5. What has been your experience in timbering ? How would you secure an engine flat—12 feet wide, 7 feet high, in order that derailed tubs may not knock out a prop or props ?
6. An overcast, to pass 20,000 cubic feet of air per minute, is to be made over a main hauling road, 12 feet wide, in daily use ; the roof is shale, with flaws. Describe how you would make it, and what materials you would use.
7. In proceeding to draw timber in pillar workings, what precautions do you think necessary, what tools would you use, and where would you commence ? Roof, fairly strong shale.
8. Describe several systems of haulage, and the conditions under which they can be used to best advantage.
9. Name the three causes of accident in coal and shale mines, and state the precautions you deem necessary to prevent or minimise the same.
10. How would you secure the side of a sinking shaft through 10 feet of very friable shale ? Show, by sketch, how you would bring up the brickwork.
11. How would you proceed to build a dam in a heading 12 feet wide, 6 feet high, to resist 20 feet head of water ? What material would you use ?
12. Show, by sketches, different methods of timbering level and inclined seams.
13. Show, by sketch, how you would secure a road in course of driving through a goaf.

5. When withdrawing timber, what precautions would you take—(*a*) when loosening the timber; (*b*) when removing it from the fall? What tools do you consider necessary for this work?

*Mine Gases, Lighting, and Ventilation.*

1. What, in your opinion, is the best safety-lamp? Describe it, with three others you are acquainted with. Give the reasons for your opinion.
2. If the ventilating fan was damaged or the furnace put out by an explosion, and you found the returns full of fire-damp, what temporary means would you adopt to restore the ventilation?
3. In a mine giving off a large quantity of fire-damp how would you ascertain if the mine was properly ventilated?
4. If 10,000 cubic feet of air are circulating through a mine, and you want to increase it to 20,000 cubic feet, how much must the ventilating current be increased?
5. Show how you would ventilate the workings on the annexed plan, having due regard to requirements for haulage, and the working of the mine with regard to the restrictions of the Coal Mines Regulation Act. (Plan not reproduced.)

---

Stafford District (1st Class), 1901.

*Ventilation.*

1. State the rules that are applicable to the resistance of air travelling through a mine: describe and state how you would be guided by such rules in laying out the general ventilation of a mine.
2. The total quantity of air circulating in a mine ventilated by a fan and natural ventilation combined is 100,000 cubic feet per minute. The quantity circulating when the fan is standing is 25,000 cubic feet per minute; what quantity would circulate if the effect of natural ventilation could be eliminated?
3. If 40,000 cubic feet of air per minute are passing through one split in a mine, which is gauged by a regulator having an opening 3 feet by 6 feet, what quantity will pass if the opening be increased to 4 feet by 6 feet?
4. Ventilate accompanying plan, marking by arrows the direction of the air-currents, putting in the necessary stoppings, doors, brattices, and lamp stations, having due regard to getting the coal from the coal faces. [Plan omitted.]

*Chemistry.*

1. What is meant by the diffusion of gases, and how is it utilised in ventilation ?
2. What are the chemical causes of spontaneous combustion in a coal mine, and what are the resultant gases ?
3. Describe how electricity is produced :—(1) By primary battery ; (2) by dynamo.

*Geology.*

1. Describe the chief characteristics of the carboniferous strata and of the strata overlying and underlying them in ordinary sequence.
2. Describe the faults usually found in coal measures, and give your opinion how they are formed.

*Arithmetic.*

1. How many tons of water will a double-acting ram pump, 10 inches diameter, 20 inches stroke, 20 strokes per minute, discharge in a day of eight hours ?
2. What quantity of fuel will be required per day, eight hours, to generate steam for an engine 20 inches cylinder, 40 inches stroke, running 60 revolutions per minute, average steam pressure 50 lb., allowing a consumption of 2½ lb. per horse-power per hour ?
3. (1) Give the square root of 18,900 ; (2) Give the cube root of 29,791,000.

*Mining Operations Generally.*

1. The following is the section of the strata, where it is proposed to sink a shaft :—

| | Feet. |
|---|---|
| Soil | 2 |
| Clay | 4 |
| Wet running sand | 6 |
| Clay | 15 |
| Sandstone Rock | — |

Explain with sketches how you would sink through this, the finished size of the pit to be 14 feet diameter.

2. Describe the ordinary operations in sinking a 14 feet shaft ; what precautions you would take for the safety of the men employed in sinking the above ?
3. Describe how you would put in the following curbs :—
   (1) Ordinary bricking curb ;
   (2) Garland curb ;
   (3) Wedging curb for tubbing.

3. Show plan and elevation of seating for Lancashire boiler. Describe all the necessary fittings.
4. In a sinking shaft at 300 feet, 600 gallons of water a minute are met. Sketch appliances you would adopt to cope with this.

*Arithmetic.—Second Day.*

1. The brushing of a road costs 8s. 6d. per fathom; coal is 3 feet thick, and weighs 18 cwt. per cubic yard; stalls are 18 yards wide; yield of round coal is 80 per cent.; find cost per ton of round coal for brushing.
2. The average cost of sinking a shaft to a depth of 600 yards amounted to £15 per yard; but 22½ per cent. of the distance cost 40 per cent. more than the average; what was the cost per yard for sinking the remaining 77½ per cent.?
3. If 8 men dig a trench 100 yards long, 12 feet deep, and 3 feet broad in 27 days, how many men will be required to dig a trench 125 yards long, 10 feet deep, and 7 feet broad in 10 days?

*Geology.*

1. How do you account for the partial or complete erosion of a coal seam?
2. Describe some of the changes which occur in the quality and regularity of position of coal seams. Give examples.
3. What do you understand by "field-work" when used in a geological sense?

*Surveying.*

1. What is the direct bearing and distance between the ends of the following traverses:—
   N. 20° 31′ W. 521 links, N. 35° 37′ W. 427 links, S. 65° 00′ E. 795 links, S. 78° W. 9·00 chains.
2. It is necessary to make specially accurate determination of levels between two points. What special and extra precautions would you adopt?
3. Describe the vernier, and sketch one reading 35° 31′.

*Ventilation of Mine Gases.*

1. Give in detail the steps you would take if called upon to direct operations immediately after an explosion in a coal mine.
2. Enumerate the gases met with in mines, and give their properties and effect on life and lights.
3. Why has ordinary blasting powder been prohibited in dry and dusty mines? Give the names and approximate composition of three of the "permitted" explosives.

*Coal Mines Regulation Act*, 1896.

1. What does the Act require regarding—
   (1) Division of mine into parts ?
   (2) Establishment of Special Rules ?
   (3) Use of safety-lamps in certain places ?

*Winning and Working of Coal and Shale.*

1. Show, by sketches, how you would sink cast-iron tubbing through 120 feet of alluvial and the means of keeping such tubbing vertical.
2. From your knowledge of mine fires and their causes, what means would you adopt and enforce to prevent them ?
3. Show, by sketches, how you would recover pillars, 30 yards by 16 yards in a 5 feet seam, with moderately hard roof, where 8-yard bords have previously been driven ; depth 700 feet.
4. Enumerate fully the precautions necessary for securing the greatest possible safety in working a gaseous mine.
5. Make sketches, showing roads 12 feet wide, 7 feet high, with bad roof, secured with :—
   (*a*) Timber,
   (*b*) Iron girder,
   (*c*) Stone or brick,

giving dimensions of material used ; depth, 800 feet.

*Machinery, Boilers, Pumps, &c.*

1. Sketch a jig-wheel, with brake attached, suitable for lowering single tubs of coal from the face of workings rising 1 in 2.
2. What is the number of revolutions of a drum in one wind if shaft is 110 fathoms deep, stroke of engines 5 feet, and diameter of drum three times length of stroke ? Find time of wind if piston speed is 400 feet per minute.
3. Sketch a fan capable of producing 150,000 feet of air per minute at 100 revolutions.
4. What appliances have been designed to arrest the fall of the cage in the event of a broken rope ? Give a sketch of any you know of used for that purpose, and show how they would be effective on wire rope or steel-rail guides.

## ILLINOIS EXAMINATION QUESTIONS.*

CONSTITUTING THE WRITTEN EXAMINATION OF APPLICANTS FOR CERTIFICATES AS MINE-MANAGERS.

*Geology.*

1. How do we distinguish the various coal seams at points wide apart ?
2. What is meant by a fault ? Describe one you have seen.
3. What is the difference between cleat and cleavage ?
4. In which of the great geological divisions are coal beds found ?

*Surveying.*

5. How would you proceed to lay off a right angle using only a tape line ?
6. How can you make certain that your compass gives a correct reading on any course ?
7. What is the area of a triangle, the sides of which are respectively 45, 63, and 92 yards ?
8. In a four-sided figure three of the interior angles are respectively 72 degrees, 95 degrees, and 130 degrees. How many degrees are there in the remaining angle ?
9. What is the angle made by two lines, the bearings of which are respectively north 25 degrees west and south 12 degrees west ?

*Mining.*

10. Describe two methods of working coal seams with which you are familiar, giving the conditions, requiring the difference in method of operation.
11. What are the advantages (if any) of narrow entry work in a field wh re the coal is over five feet in thickness and overlaid by a good roof of tough slate which does not very often break ?
12. What size of a pillar would you leave in a mine operating the coal as above described, the floor being of firm fire-clay, the depth from the surface being 250 feet ?
13. What are the conditions on which you would determine the size of a shaft which you are about to sink ?

* Questions set at Springfield in the State of Illinois, under the State Mining Board, 1902.

12. How much must the pressure or head of water be increased to pass the same quantity of water through 16 four-inch pipes as through one 16-inch pipe ?

13. The breaking strain applied at the centre of a beam 10 inches deep and 6 inches wide is 8 tons. What would be the breaking strain if the same beam was laid so that the depth would be 6 inches and width 10 inches ?

10. What gain is effected by using high pressure steam expansively rather than low-pressure steam full stroke ?
11. What is the difference between latent and sensible heat ?
12. What horse-power is required to raise 4,500 pounds of coal through a shaft 400 feet in depth in 22 seconds, the friction of engine, drum, sheave wheels, and guides being taken as one-fiftieth of the load, the cages weighing 3,000 pounds, the rope being $1\frac{1}{4}$ inch steel ?
13. Name the different kinds of safety-valves known to you, and say which one you think best, giving your reasons for your choice.
14. A boiler is to be run under a pressure of 100 pounds to the square inch. What hydrostatic pressure ought it to be submitted to in testing for safety ?

Constituting the Written Examination of Applicants for Certificates as Mine Examiners.

1. What are the characteristics, and how do we distinguish between fire-damp and black-damp ?
2. Where does the black-damp found in coal mines originate ?
3. The velocity of the current in a return air-way is 150 feet per minute. The air-way is four and a half feet in height by 6 feet in width. The number of men employed in the section ventilated by this current is 80, with eight mules and the drivers. Is the ventilation sufficient ?
4. What does the law require in reference to the examination of escapement shafts ?
5. In making an examination of a mine which occasionally produces fire-damp, where would it be necessary to use the greatest caution ?
6. What is the law in reference to places of refuge on main haulage ways ?
7. What are the duties of the mine examiner as defined by law ?
8. What is the law in reference to safety-lamps and their care ?
9. Under what conditions would you prefer to use a Mueseler safety-lamp rather than a Davy ?
10. What records should a mine examiner make of his work having been faithfully performed ?

Finis.

# ANDREW BARCLAY, SONS, & Co., Ltd.

Highest-class
SPECIFICATION
***Material***
and
**WORKMANSHIP**
in

# LOCOMOTIVES.

SLIDE,
CORLISS,
and
CORNISH
VALVE
WINDING
ENGINES.

***Corliss Valve Winding Engine.***

## PUMPING ENGINES

***Oddie-Barclay***
***High Speed Pump***

Three-Throw and
Heavy Sinking Pumps.

## CALEDONIA WORKS, KILMARNOCK, N.B.